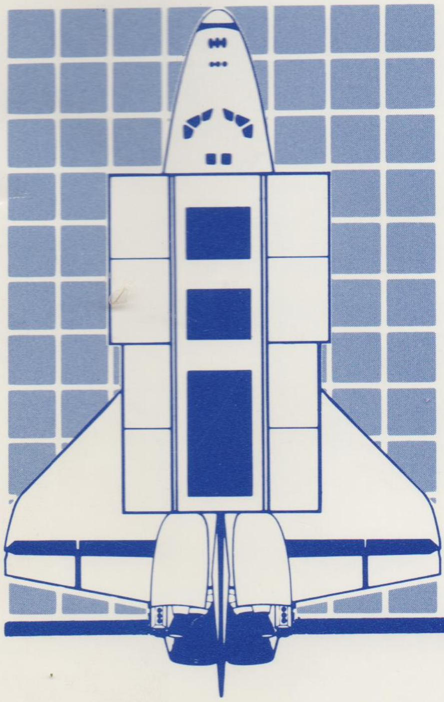
JSC-21000-HBK

STS Customer Accommodations

A Handbook for Space Shuttle Users

May 1986



National Space Transportation System

NASA
National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

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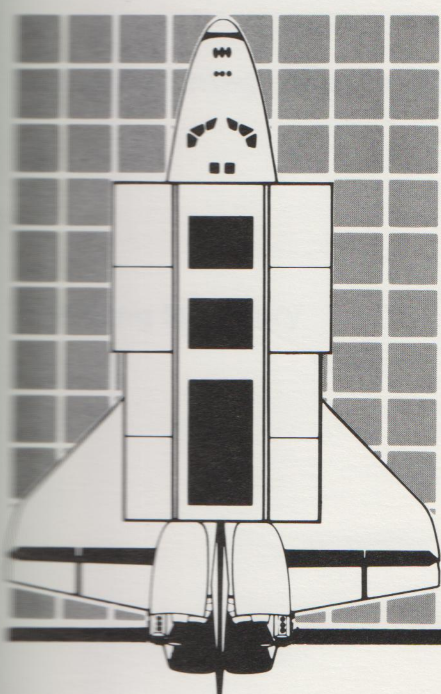

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Introduction

1

The Space Transportation System (STS) has been developed by the National Aeronautics and Space Administration (NASA) to provide easy access to space for commercial enterprises, foreign governments, the Department of Defense, and other U.S. government agencies. The principal element of the STS is the Space Shuttle. This document provides an overview of the STS and its payload accommodations to support the conceptual design of payloads and their integration into the Space Shuttle. It also serves as a guide to documents that further define design and operational requirements for Space Shuttle payloads.

Throughout this document there are references to three categories of STS accommodations for payloads: standard, small, and middeck. Many payloads, including most of the communications satellites carried by the Space Shuttle, use the standard accommodation. The small payload accommodation is for cargo bay payloads which require significantly fewer services than those provided by the standard accommodation. The middeck accommodation is provided for payloads which require the pressurized crew compartment environment, late stowage or early removal, or which benefit from the simplified development associated with direct crew operation. Accommodations other than those described by the standard, small, and middeck categories can be provided by the STS through negotiation. An initial contact to secure information regarding the appropriate accommodations for your payload is the Customer Service Center at the NASA Lyndon B. Johnson Space Center (JSC) (appendix A).

The Space Transportation System

2

The Space Transportation System (STS) provides launch services to a wide range of payloads from small hand-held experiments to large laboratories and satellites. Besides the traditional launch services, the STS can provide a variety of man-supported services in space, then return the crew, equipment, and products to Earth.

The STS is composed of the Space Shuttle plus the other flight and ground hardware and the personnel required to operate the system. Ground systems include payload and STS flight hardware processing facilities, launch and landing facilities, and crew training and mission operation facilities. In addition to pilot and mission specialist astronauts, payload specialists may fly to operate their experiments.

2.1 The Space Shuttle

The Space Shuttle is composed of the Orbiter, an external propellant tank, and two solid rocket boosters. These elements are described briefly in the following paragraphs and on figure 2-1.

a. Orbiter - The Orbiter is comparable in size and weight to a modern commercial airliner. It has three main engines and two smaller orbital maneuvering system engines mounted in the rear. Launch accelerations are limited to less than 3g by the use of throttleable main engines. In space, attitude is maintained by Reaction Control System (RCS) engines.

Its cargo bay is approximately 60 feet long and 15 feet in diameter (Fig. 2-2). Normally, several compatible payloads share each flight; however, occasionally a payload will require the entire bay.

The Orbiter carries a nominal crew of five. Displays and controls for conducting payload operations are located in the aft portion of the flight deck which is the upper level of the crew compartment (Fig. 2-3). The middeck, immediately below the flight deck, provides the living area and accommodations for middeck payloads which are defined in section 4 (Fig. 2-4).

b. External tank (ET) - The ET provides the Orbiter's main propulsion system with liquid hydrogen and liquid oxygen. After cutoff of the Orbiter main

Figure 2-1.- Space Shuttle system.

SPACE SHUTTLE SYSTEM

OVERALL LENGTH	184.2 FT (56.1 m)
HEIGHT	76.6 FT (23.3 m)

EXTERNAL TANK

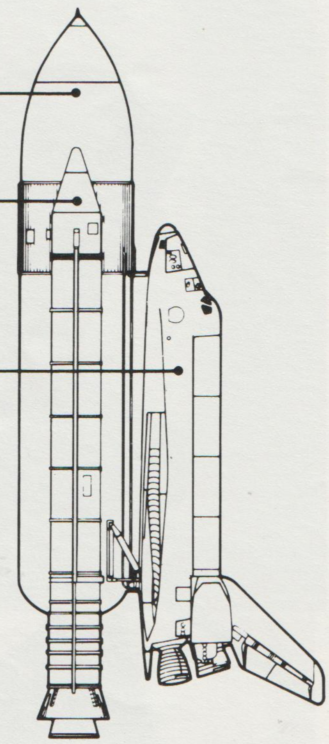
DIAMETER	27.8 FT (8.5 m)
LENGTH	154.4 FT (47.1 m)

SOLID ROCKET BOOSTER

DIAMETER	12.2 FT (3.7 m)
HEIGHT	149.1 FT (45.4m)
THRUST (EACH)	
– LAUNCH	2,700,000 LB (12,010,140 N)

ORBITER

LENGTH	122.2 FT (37.2 m)
WINGSPAN	78.1 FT (23.8 m)
TAXI HEIGHT	~57 FT (~17 m)
PAYLOAD BAY	15 FT DIAM BY 60 FT LONG (4.6 m BY 18.3 m)
MAIN ENGINES (3)	
– VACUUM THRUST EACH	470,000 LB (2,090.7 kN)
OMS ENGINES (2)	
– VACUUM THRUST EACH	6,000 LB (26.7 kN)
RCS	
– 38 ENGINES	
VACUUM THRUST EACH	870 LB (3,869.9 N)
– 6 VERNIER ENGINES	
VACUUM THRUST EACH	25 LB (111.2 N)



engines, the ET is jettisoned and breaks up in the atmosphere over remote ocean areas.

c. **Solid rocket boosters (SRB's)** - Two SRB's are fired in parallel with the Orbiter main engines to provide initial ascent thrust. The SRB's are recovered after each flight, refurbished, and reused.

2.2 Typical Space Shuttle Mission

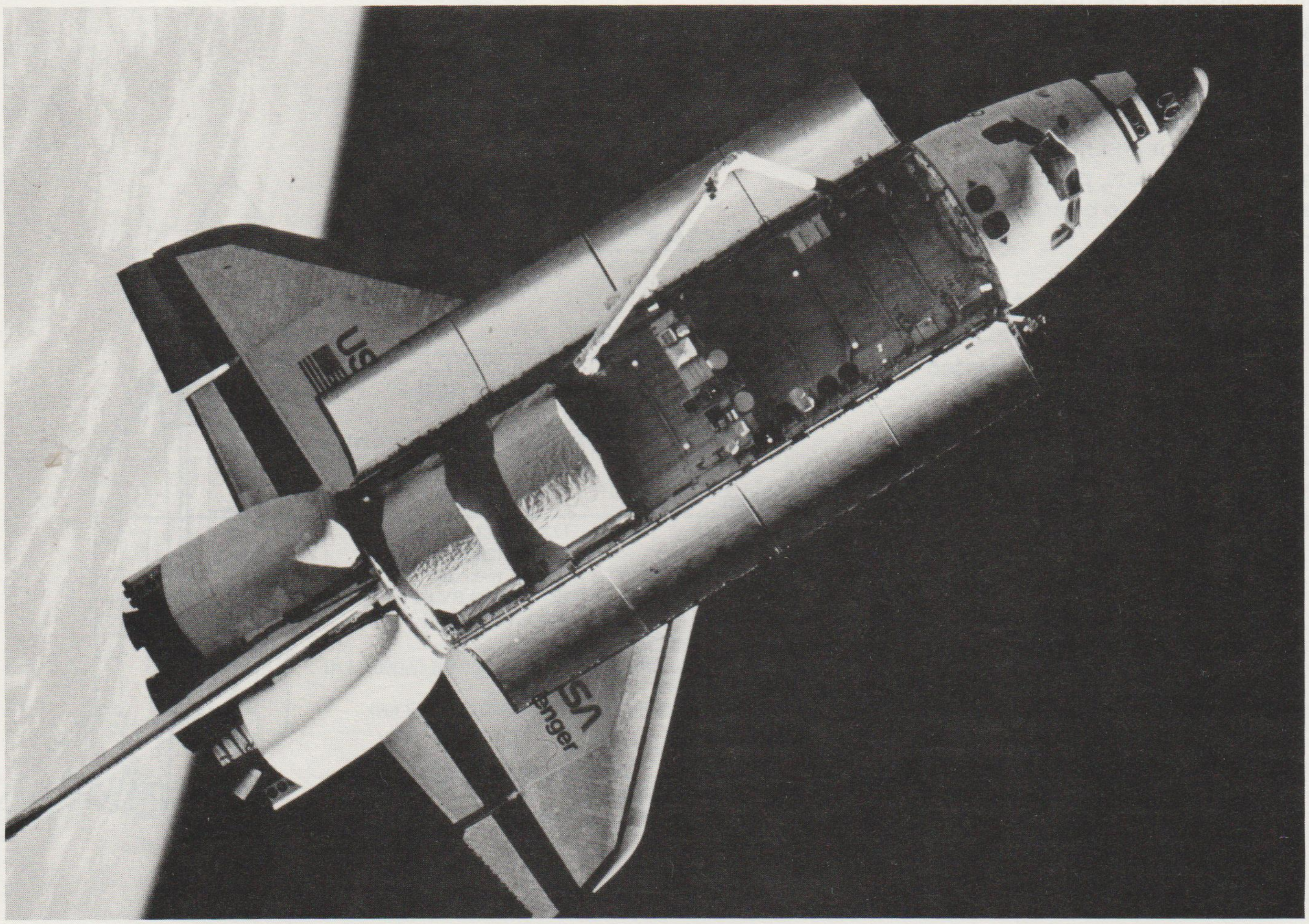
Space Shuttle launches are conducted from either the NASA John F. Kennedy Space Center (KSC) in Florida or Vandenberg Air Force Base (VAFB) in California. KSC is used for missions with orbital inclinations of 28.45 to 57 degrees; VAFB is for missions with orbital inclinations of 68 to 98 degrees. Each site consists of specialized vehicle processing and payload installation and checkout facilities, trained checkout crews, and launch operations teams.

As depicted in the Shuttle Mission Profile (Fig. 2-5), the Space Shuttle is launched with all three Orbiter main engines operating in parallel with the SRB's. SRB separation occurs approximately 2 minutes after launch. After SRB separation, the Orbiter and ET continue to ascend, using the three main engines. Main engine cutoff occurs about 8 minutes after liftoff. Then, the ET is separated. After a short coasting period, the Orbital Maneuvering System (OMS) engines on board the Orbiter are fired to provide the additional velocity required to insert the Orbiter into the proper orbit.

The cargo bay doors are opened soon after orbit stabilization to permit the Orbiter's space radiators to dissipate heat. Payload operations are then conducted by the crew from the payload station on the aft flight deck of the crew compartment. Upon completion of on-orbit operations, the cargo bay doors are closed, and the Orbiter is configured for return to Earth.

The Orbiter returns to Earth by firing its OMS engines to reduce its velocity. After reentering the Earth's atmosphere, it glides like an airplane to a landing. Primary landing sites are at KSC and VAFB. The secondary landing site is located at Edwards Air Force Base (EAFB) in California.

Figure 2-2.- Cargo bay.



2.3 Upper Stages and Carriers

Because of the ever-increasing selection and details that are subject to change, this publication does not provide details on carriers and upper stages. Customers may contact the manufacturer directly or the JSC Customer Service Center for a list of current carriers and upper stages and their manufacturers.

A number of upper stage systems have been utilized with the Space Shuttle. They provide the impulse required to transport the payloads to orbits higher than those attainable by the Orbiter. Additional stages are being developed and will be available in the future.

Carrier systems have been developed to utilize the Space Shuttle. These range from simple structural interface hardware to complex carriers providing life support, electric power, command and telemetry systems, and other specialized support.

a. **Spacelab** - The Spacelab system includes habitable modules and pallet systems which can be flown in various combinations. Flexibility in experiment objectives, design, and operation are provided by these systems. Design requirements and payload accommodations for the Spacelab are defined in the *Spacelab Payload Accommodation Handbook*, ESA-SLP-2104. For further information, contacts are listed in appendix A.

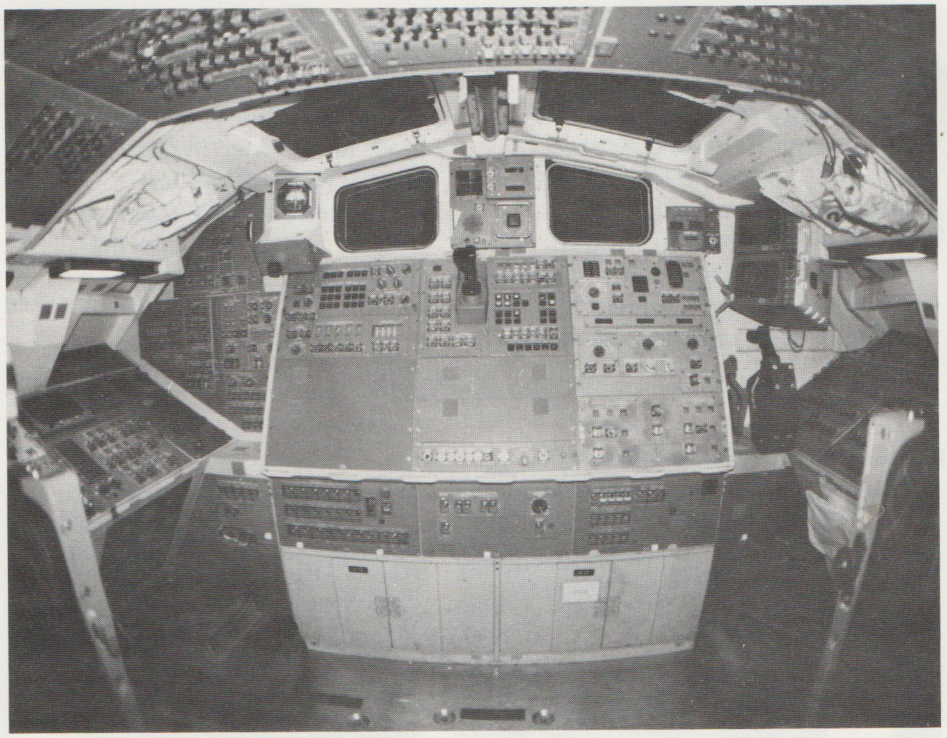
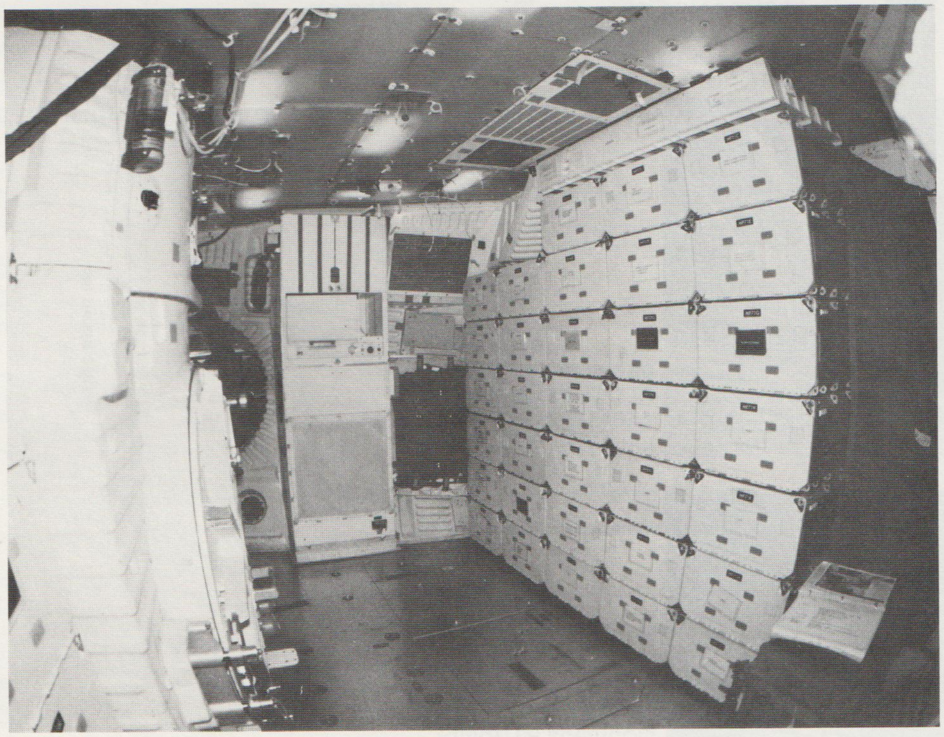


Figure 2-3.- Aft flight deck.

Figure 2-4.- Middeck.



b. Get Away Special (GAS) - The Get Away Special system provides limited payload/experiment accommodations in canisters mounted in the cargo bay. They can be flown pressurized or vented to vacuum and can provide limited viewing to the Earth and to space. The system is flown on a space-available basis and payloads are assigned on a first - come, first - served basis at a greatly reduced launch price. Payload accommodations for GAS payloads are defined in *Get Away Special (GAS) Small Self-Contained Payloads (Unnumbered)*. For further information, contacts are listed in appendix A.

Other carrier systems utilizing the small payload accommodations are being developed by NASA. These systems will offer payload/experiment accommodations between those provided by Spacelab and those provided by the Get Away Special. These systems will be flown on a space-available, non-interference basis. For further information, contacts are listed in appendix A.

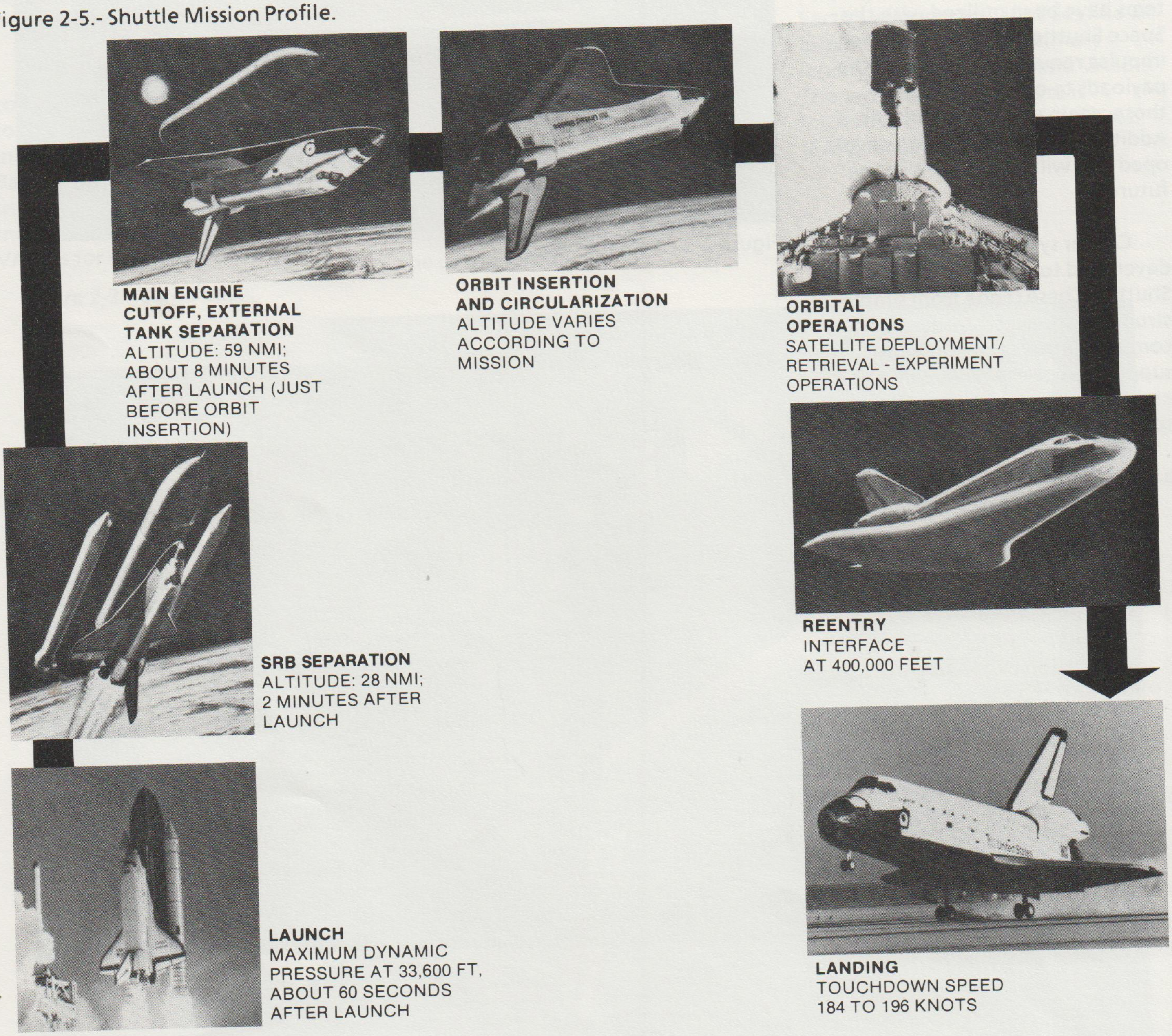


Figure 2-5.- Shuttle Mission Profile.

STS Performance Capability

3

The performance curves contained in this section represent the nominal capabilities of the Space Shuttle system to deliver cargo to orbit for routine Space Shuttle missions from the Kennedy Space Center (KSC) and from Vandenberg Air Force Base (VAFB). When payload requirements are beyond these capabilities, the customer should contact the Payload Integration Manager (PIM) assigned to their payload (reference section 6).

Figures 3-1 and 3-2 show the cargo delivery capability from KSC to 28.45-degree and 57-degree inclination orbits, respectively. These figures assume the standard Space Shuttle main engine (SSME) power levels. Additional performance can be achieved by operating the SSME's at a higher power level. However, this capability is available only through specific agreements reached with the National Aeronautics and Space Administration (NASA) during the payload integration process.

Based on the altitude and inclination requirements of the

Figure 3-1.- Cargo capability (28.45- degree inclination).

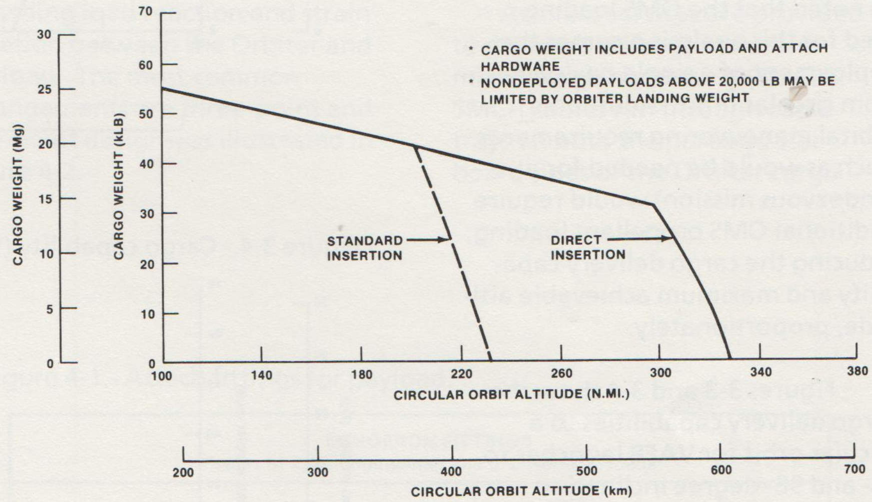
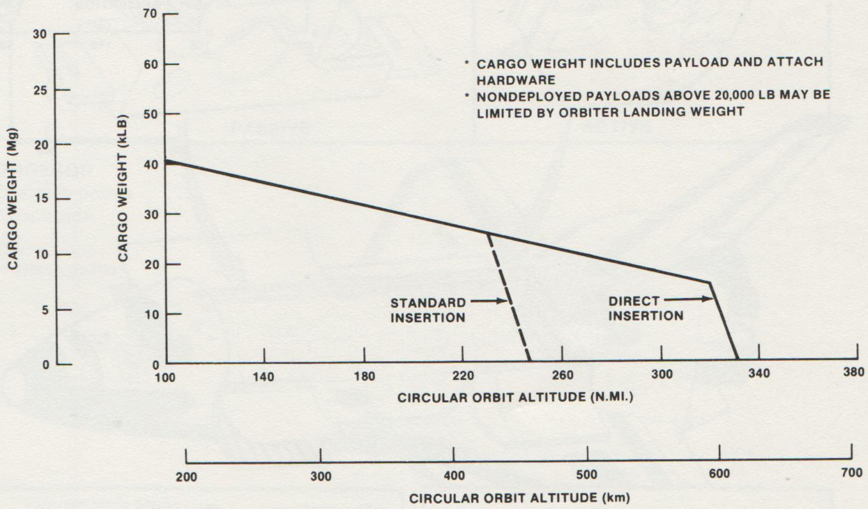


Figure 3-2.- Cargo capability (57- degree inclination).



payloads, the Shuttle's ascent trajectory is designed using a standard insertion, direct insertion, or nodal insertion technique. In each case, the cargo lift capability decreases as altitude increases, due to the need for additional Orbital Maneuvering Subsystem (OMS) propellant. This trend continues until the OMS tanks are full. To achieve still higher altitudes, a significant decrease in cargo weight is required. It should be noted that the OMS loading used for this analysis assumes the deployment of a single payload from circular orbit. Additional orbital maneuvering requirements (such as would be needed for a rendezvous mission) would require additional OMS propellant loading, reducing the cargo delivery capability and maximum achievable altitude, proportionately.

Figures 3-3 and 3-4 show the cargo delivery capabilities to a circular orbit for VAFB launches to 68- and 98- degree inclination orbits, respectively. Terminology used in these figures is explained in appendix E.

Figure 3-3.- Cargo capability (68-degree inclination).

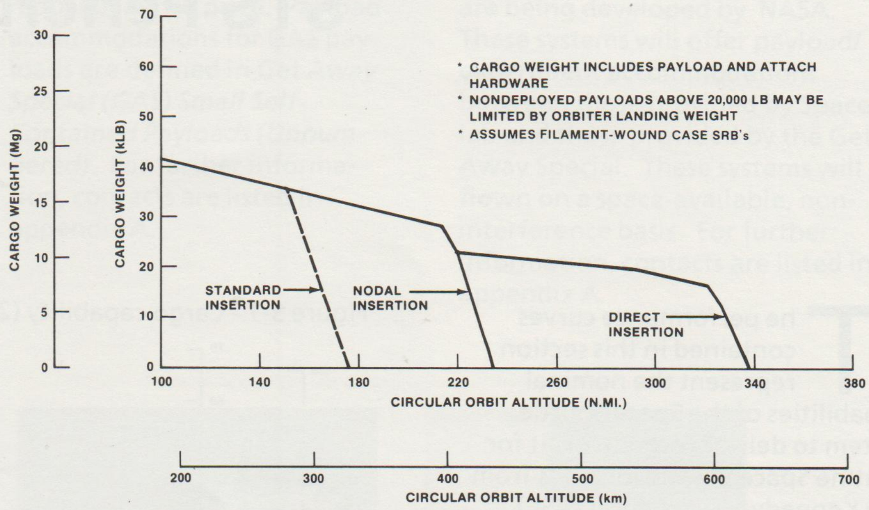
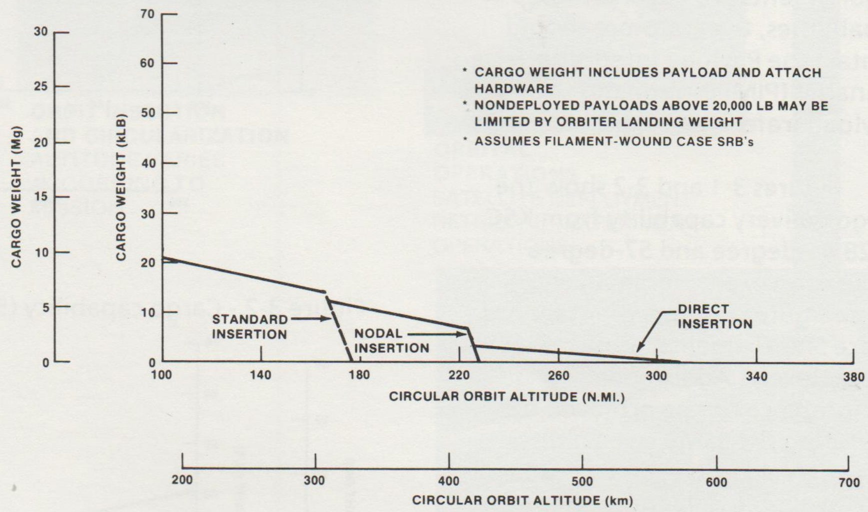


Figure 3-4.- Cargo capability (98- degree inclination).



Payload Accommodations

4

The Space Shuttle offers a wide range of payload accommodations. These are divided into standard, small, and middeck payload accommodations. Additional services and accommodations are also available on a limited basis through negotiation with the Space Transportation System (STS) . The following sections define the services and accommodations for each category.

4.1 Standard Payload Accommodations

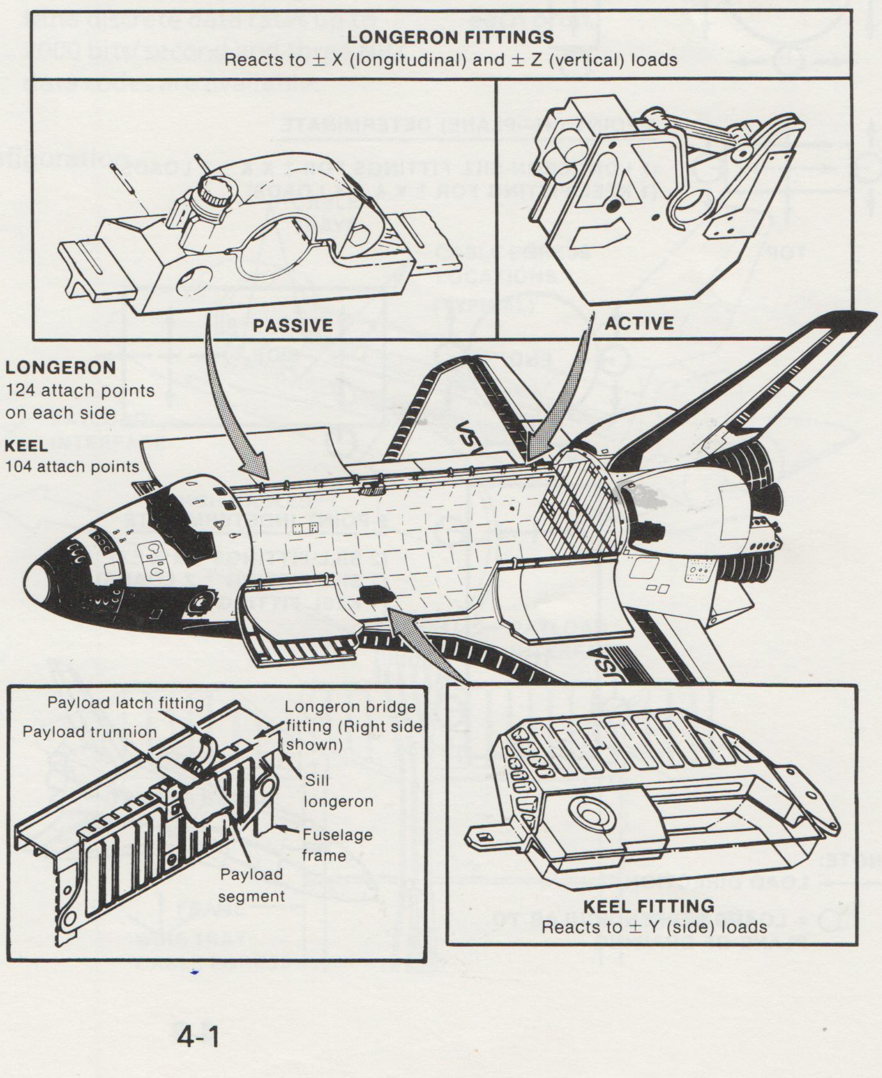
The standard accommodation provides the services required to support the operation of the majority of the cargo bay payloads. Accommodations are available for up to four standard payloads per flight and are allocated based on the payload requirements and load factors. Detailed specifications and interface characteristics of these services are defined in *Shuttle/Payload Interface Definition Document for Standard Accommodations*, JSC-21000-IDD-STD.

Physical Accommodations

The Orbiter provides structural support attachment points for customer-provided trunnions along the length of the cargo bay as indicated in figure 4-1. Payloads can be supported by attach fittings at numerous points along both sides of the cargo bay and along the bottom at the Orbiter keel centerline. Active fittings are used for deployable payloads.

These attachment provisions support various payload designs by providing load reaction and strain isolation between the Orbiter and payload. The most common arrangements are three-point and five-point designs, as illustrated in figure 4-2.

Figure 4-1.- Attach fittings for payload.



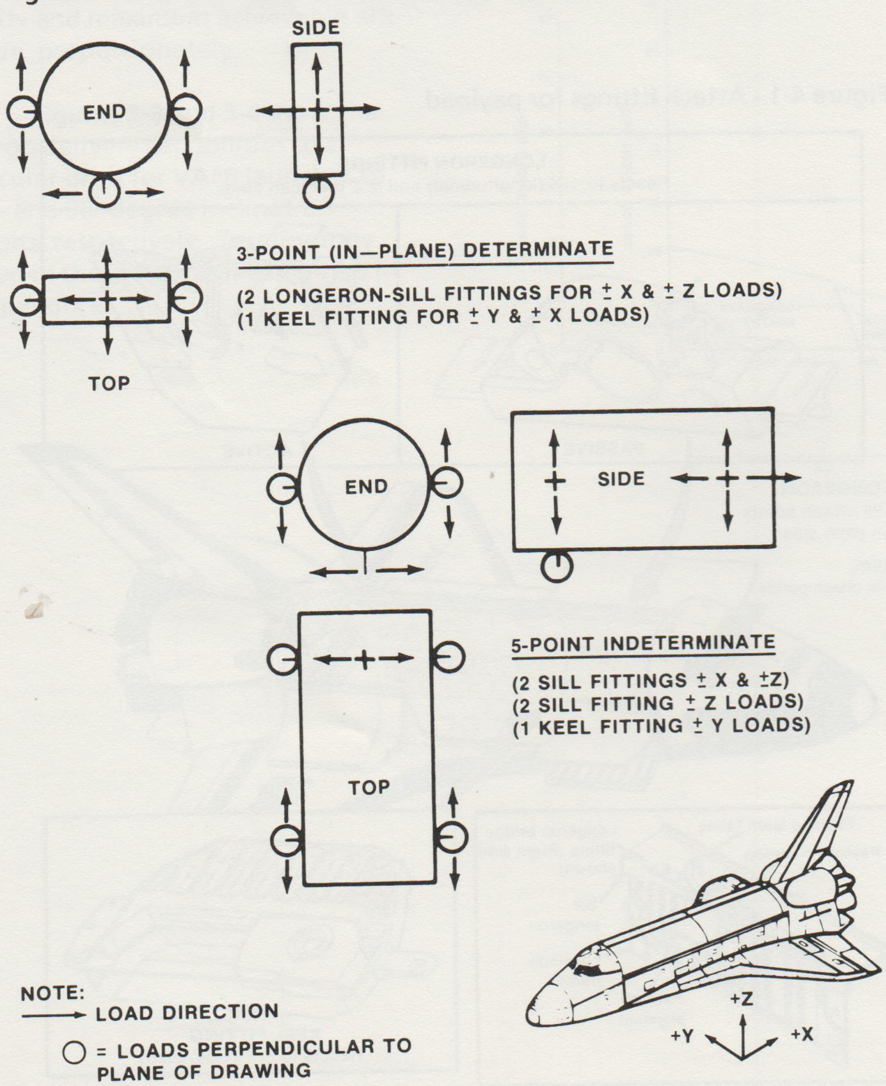
Avionics Accommodations

Avionics services are provided to payloads through standard mixed cargo harnessing (SMCH). SMCH cables run through cable trays on both the port and starboard sides of the Orbiter cargo bay. The SMCH takes power to the starboard side of the payload, signal and control interfaces to the port side, and Orbiter computer data bus interfaces to both port and starboard sides of the payload. The SMCH harness can egress the cable tray at any location along the bay. The SMCH normally egresses the cable tray at the payload location in the bay and is routed to a standard interface panel (SIP) adjacent to the payload (Fig. 4-3). This minimizes the length of the payload-provided cable to the SIP from the payload. Figure 4-4 is a diagrammatic representation of the avionics accommodations for one of the four primary payloads. These accommodations are explained in the succeeding paragraphs.

Electrical Power

The Orbiter provides electrical power to payloads at the SIP. A nominal voltage of 28 volts dc is provided during ground operations, ascent, orbital operations, and descent. For prelaunch operations, 250 watts average power is available with up to 1750 watts available for payload verification operations in the Orbiter. For ascent or descent, power up to 250 watts is available and 1750 watts average continuous power is available for orbital operations. Higher power levels are available for short periods of time to accommodate payload checkout or to accommodate active operations such as deployments.

Figure 4-2.- Three- and five-point loads support.



Command Services

Command services for payloads can be provided from the Orbiter, from the NASA Lyndon B. Johnson Space Center (JSC) Mission Control Center (MCC), and from Payload Operations Control Centers (POCC). Ground-initiated commands to attached or detached payloads are transmitted through the Orbiter communication system. The Orbiter crew can initiate commands through the Standard Switch Panel (SSP) or by entering command instructions through the keyboard into the Orbiter avionics system. This in turn generates commands in the form of discretes or serial digital signals.

The standard accommodation includes the following command capabilities:

a. **Hardwired commands from the Standard Switch Panel (SSP)** - Switch closure and/or 28-volt dc commands are provided at the SSP at the payload station on the aft flight deck. The SSP (Fig. 4-5) provides 12 switches which can be operated while in orbit by the flight crew. Overlay panels are provided to identify specific payload functions.

b. **Hardwired multiplexer/demultiplexer (MDM) commands from the Orbiter** - Discrete commands are provided at the payload wiring interface by an Orbiter MDM. They are issued by the Orbiter general purpose computer (GPC) in response to keyboard entries from the flight crew or by commands from the MCC.

The output signals provided are four discrete, high-level signals (0 to 28 volts dc) and eight discrete, low-level signals (0 to 5 volts dc).

c. **Commands via the payload signal processor (PSP)** - Serial digital commands to attached payloads may be provided through the PSP. These commands can be generated on board the Orbiter or from the MCC. The MCC provides the capability to store and generate payload commands or as an optional service to forward commands generated at the customer's POCC. Nine discrete data rates up to 2000 bits/ second and three non-return-to-zero (NRZ) data codes are available.

d. **Commands via the payload data bus** - The standard accommodation provides for connections to the payload data bus. Command data can be provided by the Orbiter through a unique customer-provided-data bus-compatible interface (like an MDM) connected to the Orbiter data bus. This enables both on-board commanding and monitoring by the flight crew or operation from the MCC. The type of command outputs that can be processed are dc discrete outputs, pulsed discrete outputs, and analog outputs.

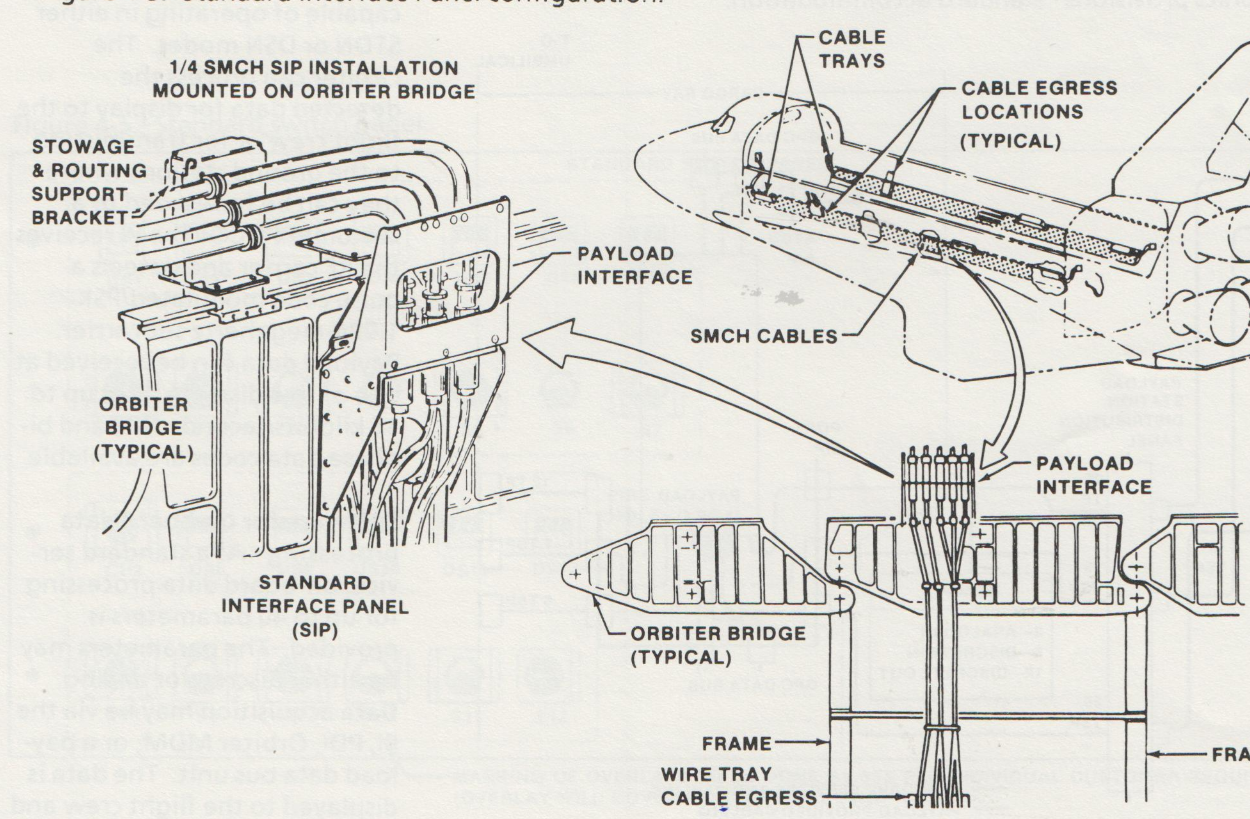
e. **Commands via the payload interrogator (PI)** - The payload interrogator provides an S-band radio frequency (RF) link to command and monitor detached payloads which are compatible with either the Spaceflight Tracking and Data Network (STDN) or the Deep Space Network (DSN). The command signal is on a 16-kHz subcarrier which is phase-shift-key (PSK)- modulated by the baseband command signal. Nine discrete data rates up to 2000 bits/ second and three NRZ data codes are available.

f. **Software for on-board-initiated single commands** - The on-board command processing capability provided as a part of the standard accommodation includes provisions for initiating 40 single commands. These commands can be issued to a payload-provided bus terminal unit, an Orbiter MDM, the PSP, or the PI.

Data Processing and Display Services

Payload data processing and monitoring can be provided on board the Orbiter, at the MCC, and at customer POCC's. Payload telemetry is forwarded by the Orbiter communications systems to the MCC and customer POCC's. When the Tracking and Data Relay Satellite System (TDRSS) is operational, communications will be available for a large percentage of each orbit.

Figure 4-3.- Standard Interface Panel configuration.



Each payload is provided the following data processing and display capability:

a. **Hardwired displays from the Standard Switch Panel** - The SSP provides 12 status indicators (talkbacks) to enable the flight crew to monitor payload status and operation. These indicators are normally used during active crew control of payload operations. They are not monitored during crew sleep periods.

b. **Hardwired data and displays from the Orbiter multiplexer/ demultiplexer (MDM)** - The MDM is capable of receiving eight discrete low level signals (0 to 5 volts dc) and two analog differential signals (0 to 5 volts dc) for on-board data processing or for transmission to ground stations.

Analog and discrete payload signals received by the Orbiter MDM can be monitored on board, at the MCC, and at the customer POCC. These signals may be "limit sensed" by the Orbiter GPC such that the flight crew is visually or audibly notified when predetermined limits or conditions are exceeded.

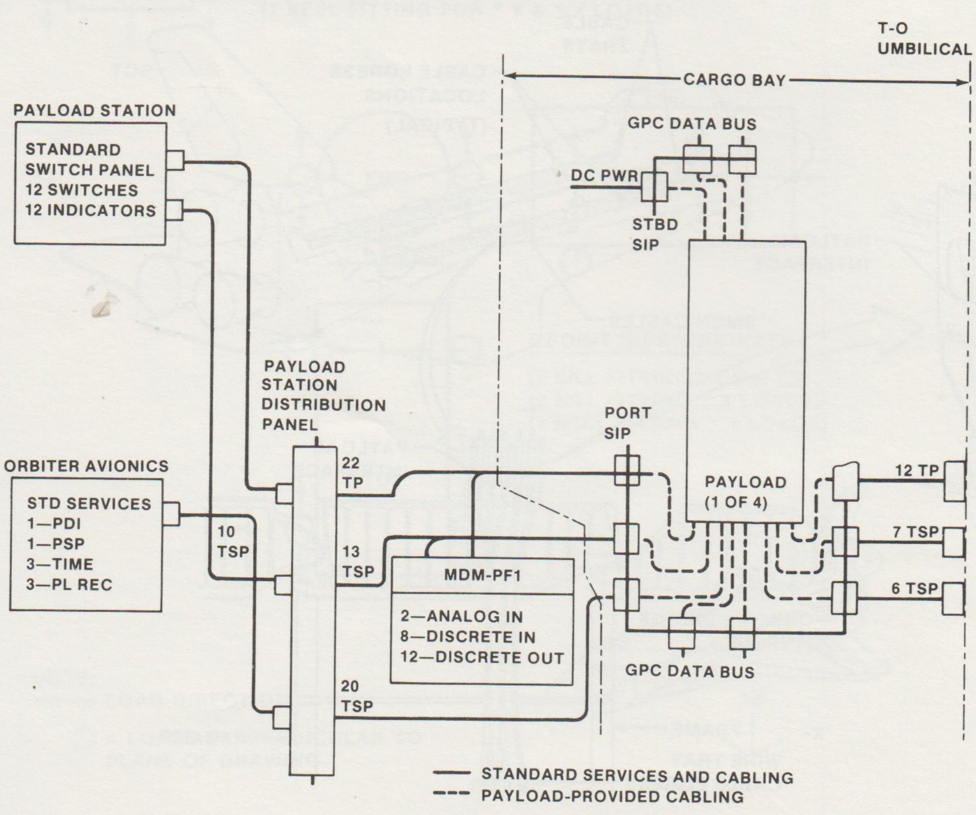
c. **Data and displays via the payload data interleaver (PDI)** - Compatible payload telemetry data can be input to the PDI for forwarding to the customer POCC. During ascent, telemetry may be sent to the ground at a nominal rate of 1 kilobit/second per payload. While in orbit, the payload telemetry sent to the ground will nominally be limited to 8 kilobits/second per payload except when a payload is being deployed. During checkout and deployment, a payload may send data at a maximum rate of 32 kilobits/ second for up to 20 minutes. During these periods, other payloads will be allowed to send telemetry to the ground at a nominal rate of 1 kilobit/ second each. The capability for on-board processing (8 bit words) is also provided. This provides display and limit sensing for flight crew monitoring and payload operation. NRZ-L is the preferred coding; alternatively, bi-phase-L can be employed.

d. **Data and displays via the data bus** - Customer-provided data bus units which are compatible with the Orbiter system can be connected to the payload data bus to provide data acquisition and processing for display to the flight crew. The data can be dc discretes and/or analog inputs. These data can also be transmitted to the ground where they can be forwarded to a customer POCC.

e. **Data and displays via the payload interrogator (PI)** - Data from detached payloads are received by the PI, which is capable of operating in either STDN or DSN modes. The Orbiter can process the detected data for display to the flight crew or for transmission to the ground stations where they can be forwarded to a customer POCC. The PI receives the RF carrier and detects a pulse code modulated/PSK 1.024-megahertz subcarrier. Payload data can be received at one of five discrete rates up to 16 kilobits/second. NRZ and bi-phase data codes are available.

f. **Software for on-board data processing** - As a standard service, on-board data processing for up to 40 parameters is provided. The parameters may be either discrete or analog. Data acquisition may be via the PI, PDI, Orbiter MDM, or a payload data bus unit. The data is displayed to the flight crew and

Figure 4-4.- Avionics provisions - standard accommodation.



may, in limited quantities, be transmitted to the MCC and subsequently forwarded to a customer POCC.

Recording

The standard accommodation includes three parallel tape recording channels, one analog and two digital, on the payload data recorder. Ten minutes of recording time is available during each of the following mission phases: ascent, descent, and payload deployment. All payloads may record data when the recorder is operating. The payload recorder will accept digital input data rates from 32 to 64 kilobits/second or analog data from 1.9 to 125 kilohertz.

Timing

The standard accommodation includes one mission-elapsed time (MET) signal and two Greenwich Mean Time (GMT) signals in Inter-range Instrumentation Group B (IRIG-B) modified code format.

Thermal Conditioning

Before the Orbiter cargo bay doors are closed in preparation for launch, the cargo bay atmosphere is controlled by the rotating service structure (RSS) air conditioning system. The nominal temperature during this period is 70 plus or minus 5 degrees Fahrenheit. After the doors are closed, a flow of conditioned gas (air or gaseous nitrogen) is supplied to the cargo bay. The inlet temperature of this gas is controlled to plus or minus 5 degrees Fahrenheit in the range of 60 to 70 degrees Fahrenheit. The humidity of the purge gas is less than 50 percent. Filtered, temperature-controlled air is available within approximately 1 hour after landing at the landing site.

Ground Support Equipment Umbilical

The ground support equipment (GSE) umbilical, also known as the T-O umbilical, is separated from the Orbiter at liftoff. T-O umbilical wiring is provided to enable payload monitoring, commanding, and trickle charging of batteries prior to liftoff. The standard accommodation includes 12 twisted-wire pairs and 13 twisted, shielded-wire pairs.

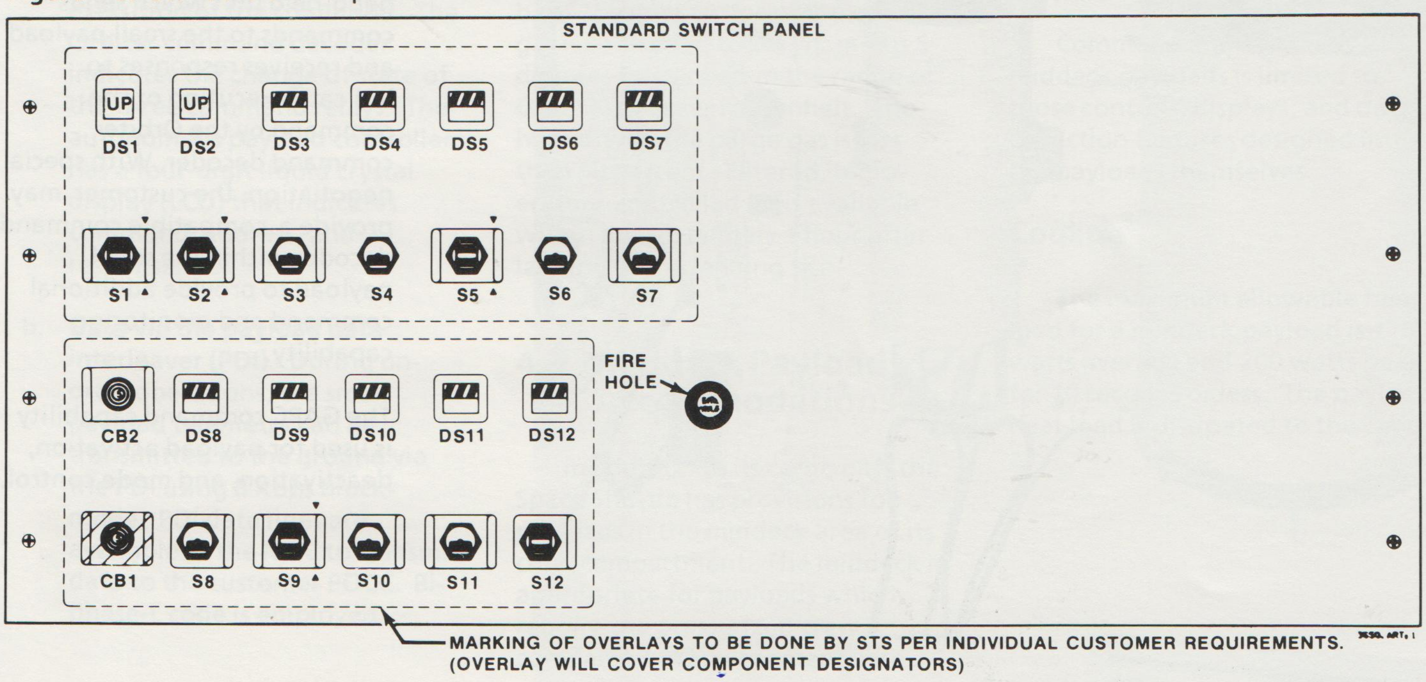
Pointing

The STS is capable of pointing the Orbiter/payload structural interface to within 1 degree of the desired direction for the scheduled payload deployment periods. For longer pointing periods, some degradation in accuracy must be expected.

Payload Deployment

A payload can be deployed at customer-specified orbital parameters. The flight design will provide a primary opportunity and at least one backup opportunity to deploy the payload. Separation can be provided by the payload airborne support equipment (ASE) or by STS-supplied active retention latches.

Figure 4-5.- Standard switch panel.



Payload deployment can be accomplished by the Orbiter Remote Manipulator System (RMS) (reference section 4.4) if the payload has a compatible grapple fixture.

4.2 Small Payload Accommodations

Small payload accommodations are available to support cargo bay payloads which do not require the full range of the standard accommodations. Provisions for mounting small payloads can only be made in the forward area of the cargo bay. Detailed specifications of the services and interface characteristics are defined in *Shuttle/Payload Interface Definition Document for Small Payload Accommodations,* JSC-21000-IDD-SML.

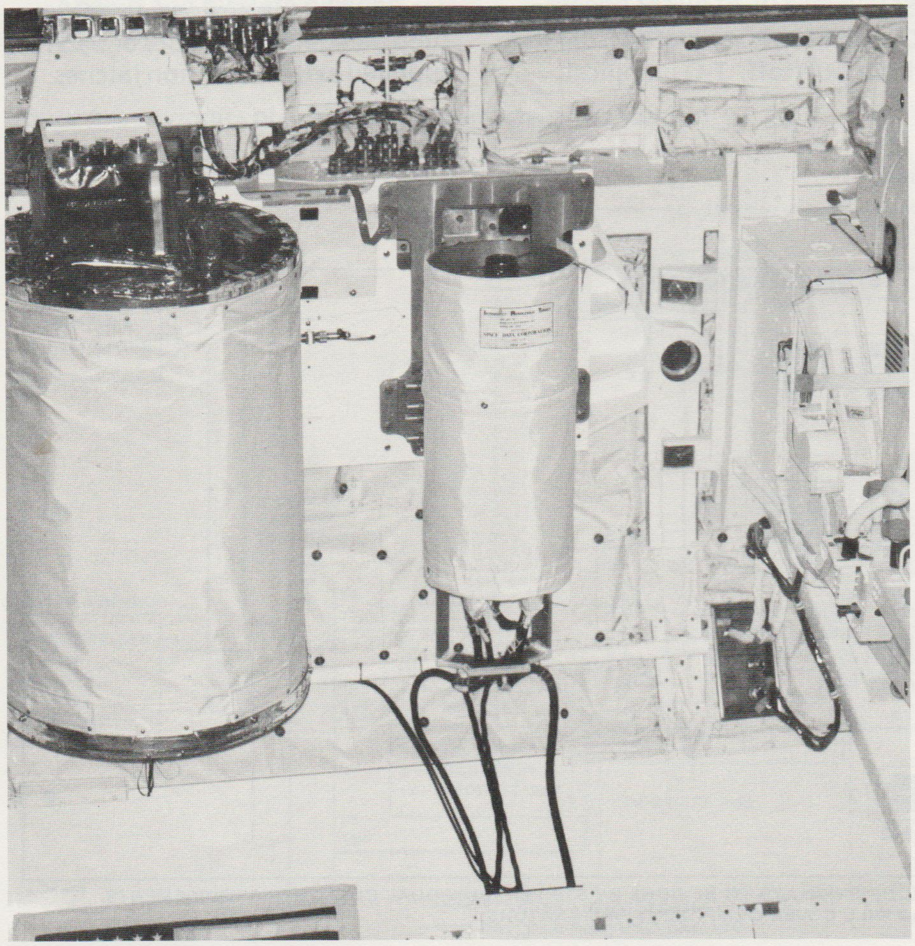


Figure 4-6.- Sidewall-mounted payloads.

Physical Accommodations

Payloads using the small payload accommodation can be mounted in either a side-mounted or an across-the-bay configuration. In the side-mounted configuration, the payload is mounted on a sidewall payload carrier (Fig. 4-6). This accommodation is provided on the starboard side of the cargo bay only. The sidewall payload carrier is similar to the typical Orbiter bridge shown in figure 4-3. In the across-the-bay configuration, the payload is mounted on a customer-provided structure using the attachment provisions described in the accommodations for standard payloads in section 4-1.

Electrical Power

A maximum of 1400 watts of nominal 28-volt dc electrical power is available at the standard interface panel (SIP) (Fig. 4-4) for prelaunch checkout and orbital operations. Small payloads may be constrained to 300 watts during other payloads' high power demand periods.

Command Services

Payloads using the small payload accommodation can be commanded by limited discrete commands originating on board, or by serial digital commands originating at a customer's POCC.

The following services are available on a time-shared basis with the Orbiter and other payload operations:

a. **Commands via on-board Get Away Special Autonomous Payload Controller (GAPC) Interfaces** - Six commands (contact closures) are provided to the small payload from the Orbiter flight deck via a GAS-type data bus controller system. The GAPC is a crew-operated, hand-held unit which sends commands to the small payload and receives responses to indicate execution of the command by the Orbiter command decoder. With special negotiation, the customer may provide a compatible command decoder within the small payload to provide additional command and monitoring capability.

   The GAPC command capability is used for payload activation, deactivation, and mode control.

b. **Commands via the payload signal processor (PSP)** - Serial digital commands are provided by the PSP at 2 kilobits/second. The commands are generated at the customer's POCC and relayed to the Orbiter through the MCC. This capability will be time-shared with other payloads on the same flight. The NRZ-L data code is employed.

Data Processing and Display Services

Payload data processing and monitoring is provided on board the Orbiter and at the customer's POCC. The STS capability to provide telemetry data to the customer POCC is time-shared with other payloads.

Each payload is provided with the following data processing capability:

a. **Display of command responses via the autonomous payload controller data bus** - The autonomous payload controller unit receives responses from the Orbiter or customer-provided command decoder to indicate execution of the command. The Orbiter command decoder indicates the change of state of the three command relays. The autonomous payload controller has a four-digit liquid crystal display (LCD) that indicates command, address, and response.

b. **Data via the payload data interleaver (PDI)** - During on-orbit operations, the small payload telemetry can be transmitted to the ground via the PDI using 8 Kbps block-mode. PDI data lines are available at the MCC to transmit data to the customer POCC. Bi-phase-L code is employed.

c. **Data via the K_u-band signal processor** - The 2-megabit/second K_u-band signal processor channel is available to the small payload on a time-shared basis. The payload K_u-band data will be available from the NASA Goddard Space Flight Center (GSFC). The data code is NRZ. Routing and availability of the data will be defined in the customer-specific payload integration plan (PIP).

Timing

The small payload accommodation includes one mission elapsed time signal in Interrange Instrumentation Group B (IRIG-B)/modified code format.

Thermal Conditioning

Before the Orbiter cargo bay doors are closed in preparation for launch, the cargo bay atmosphere is controlled by the rotating service structure (RSS) air conditioning system. The nominal temperature during this period is 70 plus or minus 5 degrees Fahrenheit. After the doors are closed, a flow of conditioned gas (air or gaseous nitrogen) is supplied to the cargo bay. The inlet temperature of this gas is controlled to plus or minus 5 degrees Fahrenheit in the range of 60 to 70 degrees Fahrenheit. The humidity of the purge gas is less than 50 percent. Filtered, temperature-controlled air is available within approximately 1 hour after landing at the landing site.

4.3 Middeck Payload Accommodations

In addition to its cargo bay, the Space Shuttle has provisions for payloads in the middeck area of its crew compartment. The middeck is appropriate for payloads which require the pressurized crew compartment environment, late stowage, early removal, or direct crew operation. Detailed specifications of the services and interface characteristics are defined in *Shuttle/Payload Interface Definition Document for Middeck Payload Accommodations,* JSC-21000-IDD-MDK.

Physical Accommodations

As depicted in figure 4-7, middeck payloads are stored in lockers. Each locker carries up to 60 pounds of cargo and provides 2 cubic feet of volume. Trays with dividers can be installed to separate each locker into as many as 16 compartments.

Electrical Power

Nominally, up to 5 amps of 28-volt dc power is available only during the orbital phase. The total power consumed by any payload is limited to 115 watts average for up to 8 hours or 200 watts peak power for 10 seconds or less. Standard cables are available for routing power from utility outlets to stowage locations for experiments requiring them.

Command and Monitoring

Command and monitoring of middeck payloads is limited to those controls, displays, and data-collection features designed into the payloads themselves.

Cooling

The maximum allowable heat load for a middeck payload is 115 watts average and 200 watts peak for 10 seconds or less. The payload heat load is dissipated to the cabin air.

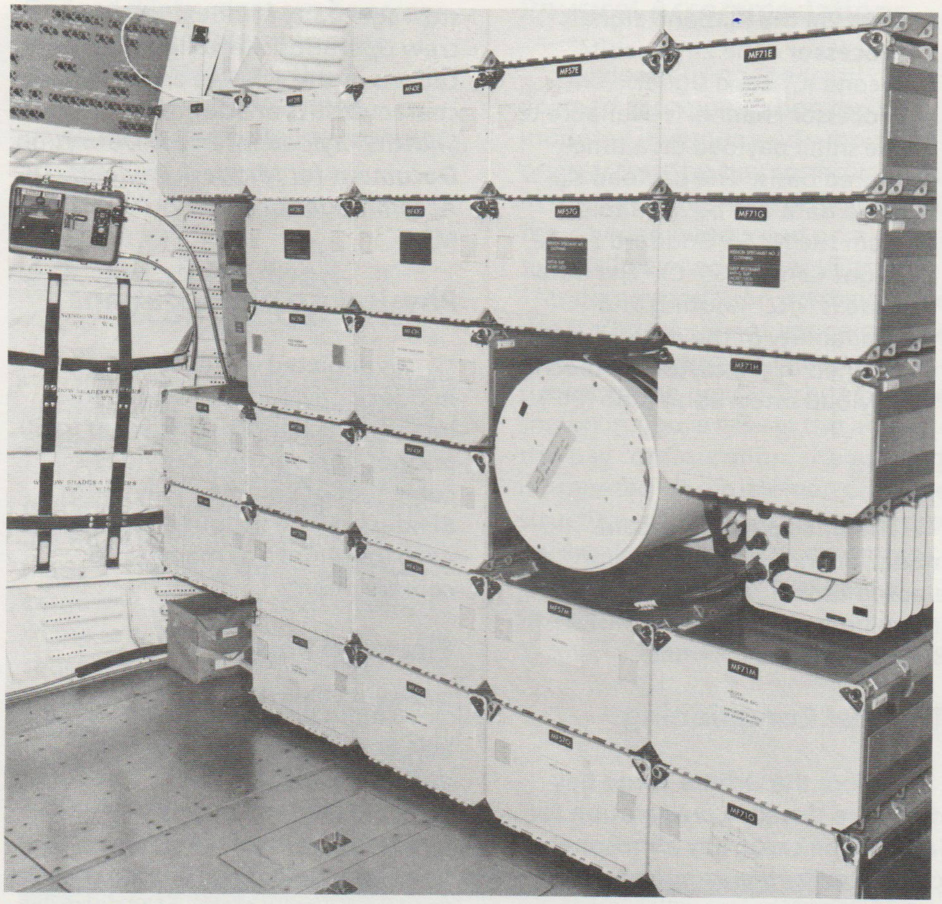


Figure 4-7.- Middeck lockers.

4.4 Additional Services and Accommodations

In addition to the standard, small, and middeck payload accommodations, the STS can provide other services to support payload operations. These services are generally not required by the majority of the STS payloads. Some are restricted by the Orbiter design and can be provided to only a limited number of payloads on each flight. Customer requirements for these additional services are defined on a case-by-case basis. This section describes some of the additional services available. For detailed specifications and interface characteristics, contact the JSC Customer Integration Office.

Auxiliary DC Power

Auxiliary 28-volt dc power can be provided in the cargo bay if additional redundancy is required for payload safety. Power up to 150 watts is available during ascent, while in orbit, and during entry.

AC Power

Three-phase, 115-volt ac electrical power can be provided in the cargo bay at the standard interface panel. Power levels of 85 volts-amps average and 105 volts-amps peak for 2 minutes per phase are available.

On-board Data Processing

Provision can be made for on-board data processing of parameters in excess of the 40 which are provided as a standard service (section 4-1).

Payload Retention Latch Power and Control

Control capability and three-phase, 400 hz, 115 volt ac electrical power is available for orbital operation of customer-provided payload actuators. Electrical characteristics and control logic must emulate those of the Orbiter payload retention latches. The services are available at electrical connectors on the Orbiter sill longerons. Physical interfaces for the interconnecting cabling are defined in the customer's Interface Control Document (ICD).

Deployment and Pointing Panel

Provisions can be made for payload deployment and payload manual pointing by means of a deployment panel located in the aft flight deck and a manual pointing controller which operates in conjunction with it. Special wiring provisions are required.

Extravehicular Activity

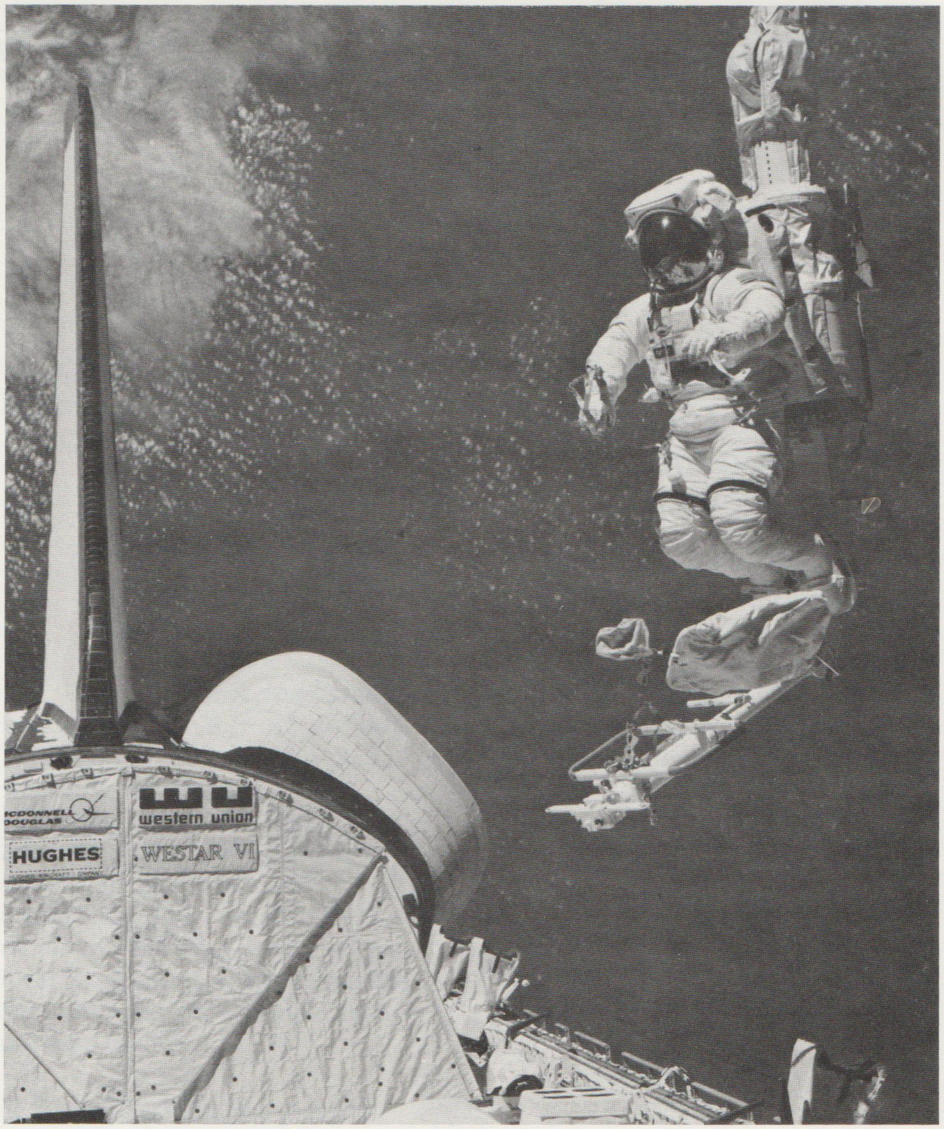
The term extravehicular activity (EVA) as applied to the Space Shuttle includes all activities during which crewmembers don space suits and life support systems, leave the Orbiter cabin, and enter a vacuum environment. This permits the EVA crew to perform hands-on operations on the payload. The conditions for performing EVA are specified in the customer PIP. For additional details regarding EVA planning, capability, and design criteria, see *JSC-21000-INF-XXX, Extravehicular Activities (EVA)*.

Remote Manipulator System

The RMS is a mechanical arm that can deploy/retrieve payloads. It is 50 feet, 3 inches in length and is mounted along the port side of the cargo bay, outside of a 15-foot diameter reserved for cargo.

Displays and controls for the RMS are located in the aft flight deck. The RMS can be commanded to operate in accordance with predetermined payload handling sequences or in an automatic sequence created on orbit by the operator. Payloads equipped with an RMS-compatible grapple fixture and structural interfaces for retention can be retrieved from low Earth orbit by the Orbiter. The RMS is used to grapple a payload and place it in retention latches. This provides the capability to service, repair, or return to Earth payloads which have been previously deployed. It must be observed that retrieval missions are far more complex and costly than are nominal missions.

For further information on the RMS, see *JSC-21000-INF-XXX, Remote Manipulator System (RMS)*.



STS Customer Documentation

5

The STS customer documentation tree shown in figure 5-1 lists the documents of primary importance to new Space Shuttle customers. The documents described in this section contain information that is applicable to all customers. The documents prepared specifically for each payload are discussed in section 6 along with a general discussion of the payload integration process.

These documents contain detailed descriptions of Space Shuttle payload accommodations, interfaces, requirements, and procedures. The information has been structured for three types of payload accommodations: standard, small, or middeck (reference section 4). This enables STS customers to select the Standard Integration Plan and Interface Definition Document (IDD) appropriate to their payload. The customer can also select from a set of information documents that provide useful data on the integration processes, on subsystems, and on other technical subjects.

5.1 Safety Documents

The STS safety requirements are defined in *Safety Policy and Requirements for Payloads Using the Space Transportation System* (NHB 1700.7A) and the *Space Transportation System Ground Safety Handbook (SAMTO HB S-100/KHB 1700.7)*. The safety review process is described in *Implementation Procedures for STS Payloads Safety Requirements*, (JSC-13830).

5.2 Shuttle/Payload Standard Integration Plan (SIP)

Each Shuttle/Payload Standard Integration Plan is structured as a "blank book" to serve as a guide, or standard, for preparing the customer-specific Payload Integration Plan (PIP) (reference section 6). Each Standard Integration Plan contains the technical requirements, management interfaces, services, and schedules that are applicable to the class of payload involved.

5.3 Shuttle/Payload Interface Definition Document (IDD)

Similarly, the Shuttle/payload IDD's contain the standard payload accommodations and define those interfaces that are standard for the type of accommodations covered. The IDD is used as the basis for the customer-specific Interface Control Document (ICD). Payloads that require a dedicated mission should contact the Customer Integration Office (appendix A).

5.4 Shuttle/Payload Integration Information Documents

These documents provide additional information on a variety of subjects such as the integration process, guidelines for the design and analysis of payloads, and the design and operational requirements for utilizing specialized STS services.

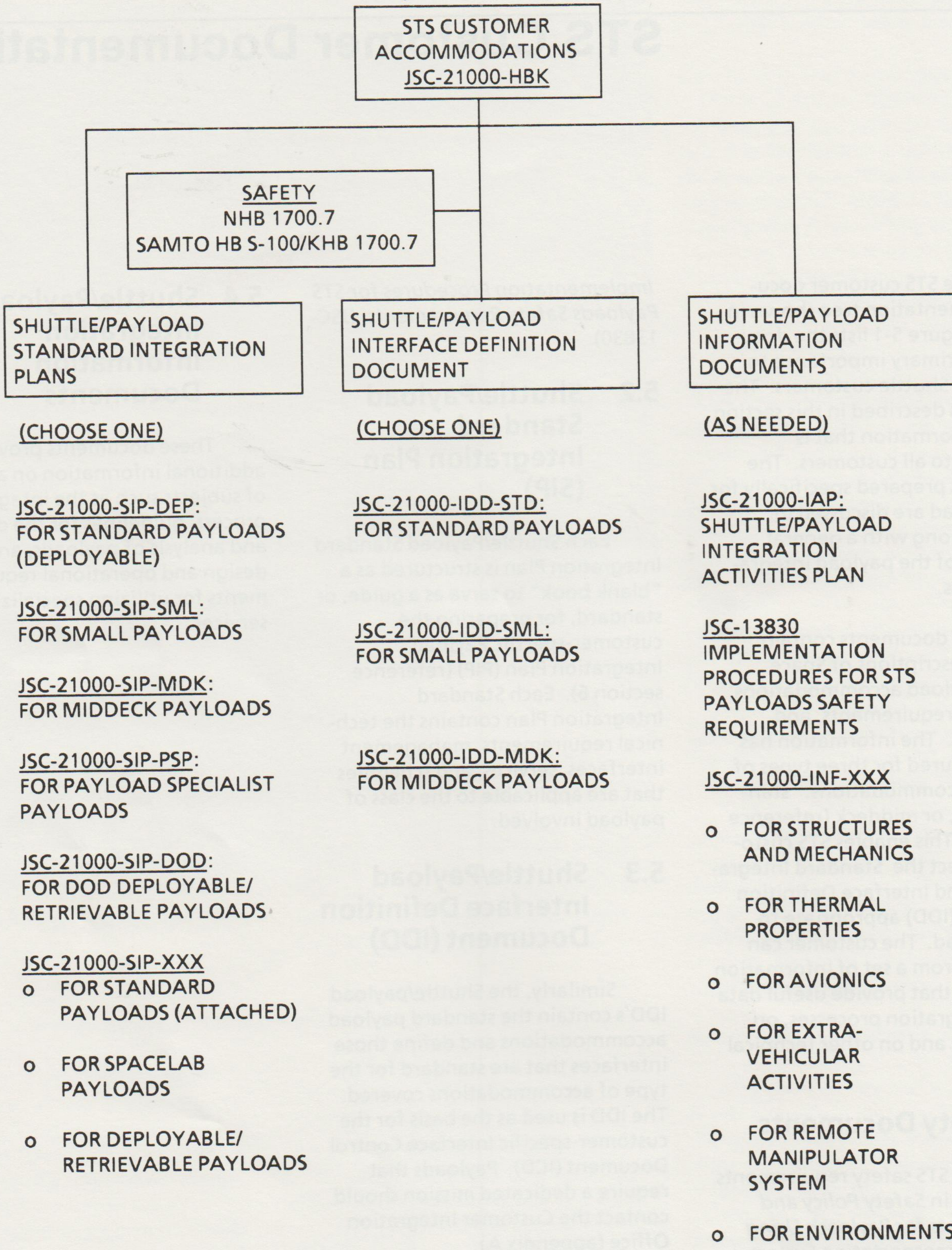


Figure 5-1.- STS Customer Documentation Tree

Payload Integration Process

6

This section presents a summary of the activities and the customer-specific documents required to integrate a specific payload into the Space Shuttle.

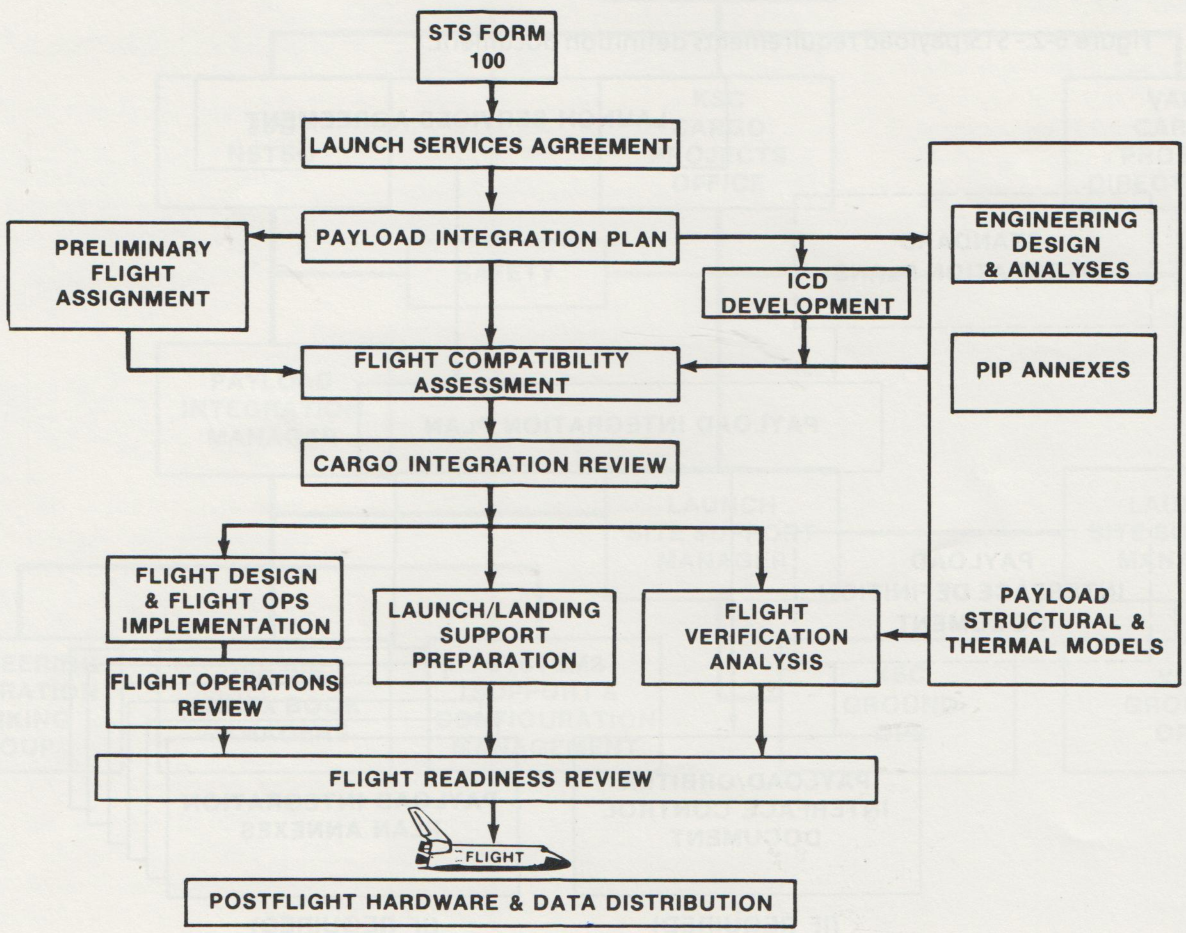
6.1 Overview

The first step in the formal integration process is for the customer to submit a Request for Flight Assignment (NASA STS Form 100) to National Aeronautics and Space Administration (NASA) Headquarters, Washington, D.C. Figure 6-1 depicts the overall flow, from the receipt of a Form 100, to the post-flight distribution of payload related hardware and data. The relationship between the generic documents discussed in section 5 and the customer specific documents discussed in this section is illustrated in figure 6-2.

The integration process consists of two phases prior to launch. These phases are the development of the formal agreements between the customer and NASA and the detailed implementation of these agreements and plans.

The schedule for key events during the first phase is determined by the development of the payload but is constrained to be completed in time to support the Cargo Integration Review (CIR). During the second phase, the schedules are established by the STS to meet the launch date.

Figure 6-1.- Payload integration process.



6.2 Development of the Formal Agreements

Development of the formal agreements between the customer and NASA is conducted by a NASA team composed of representatives from NASA Headquarters, the NASA Lyndon B. Johnson Space Center (JSC), the NASA John F. Kennedy Space Center (KSC), and the Vandenberg Air Force Base (VAFB) (Fig. 6-3).

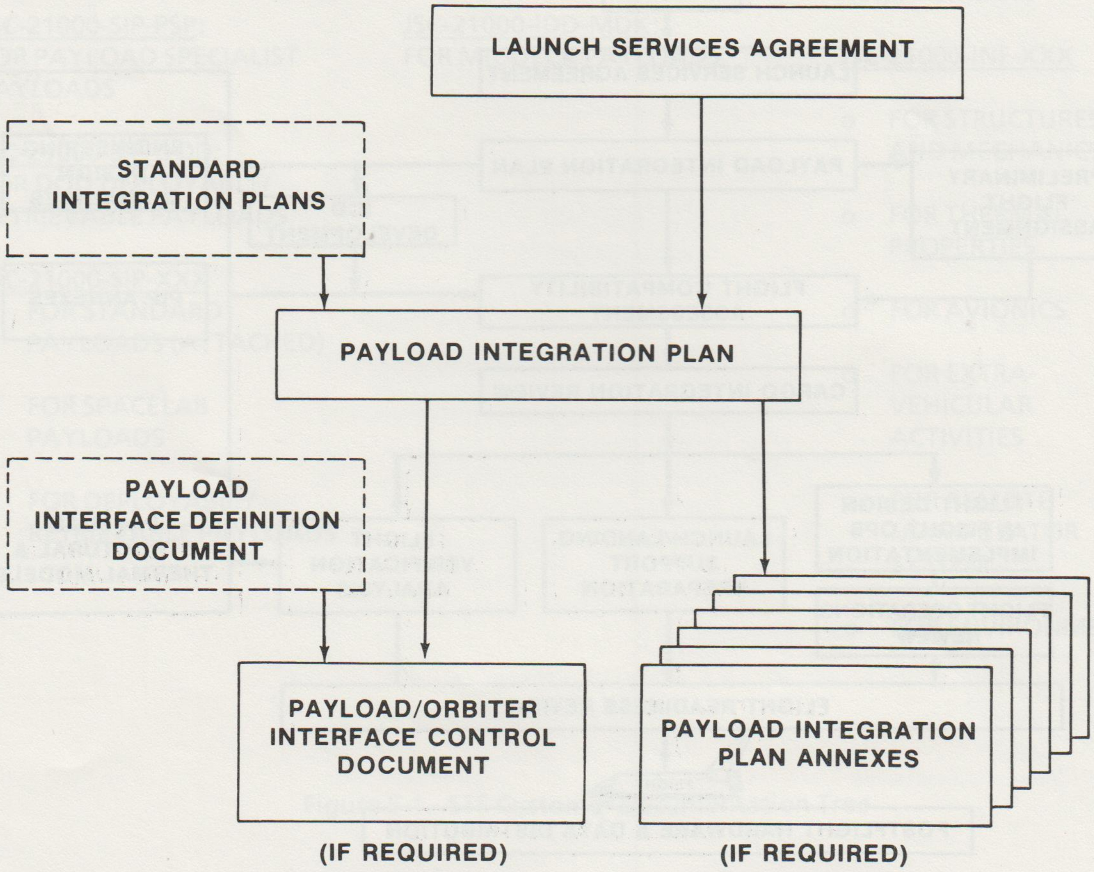
First contact is usually with one of several offices at NASA Headquarters depending upon the type of payload involved. A Customer Service Manager from the Customer Services Division is assigned to help the customer get started and to discuss and negotiate nontechnical policies, terms, and conditions imposed on both parties. These agreements are documented in the Launch Services Agreement (LSA) which becomes the formal contract between the customer and NASA when signed by both parties. An STS Form 100 and earnest money, or their equivalents, are submitted to the Customer Services Division at NASA Headquarters early in the process to indicate a desire to be placed on the manifest.

The Customer Services Division transmits the Form 100, or its equivalent, to JSC, authorizing the technical integration process to begin. At JSC, each customer is assigned a Payload Integration Manager (PIM), who remains the customer's primary technical point of contact throughout the entire process. The PIM is responsible for ensuring the customer requirements have been accurately defined and documented, are compatible with the Orbiter's payload accommodations, and are properly implemented. The PIM also coordinates any engineering or other technical support required at JSC.

The PIM begins by inviting the customer to an introductory meeting at JSC. At this meeting, the PIM reviews the integration process and introduces the key JSC and KSC personnel with whom the customer will be working. The customer describes the payload, and formal development of the customer's requirements begins.

All of the technical agreements are developed with JSC except for those associated with the launch site processing of the customer's payload. These are developed with the launch sites. Then the top level launch site requirements are incorporated into the Payload Integration Plan (PIP). When the customer is ready to discuss the details of payload hardware processing, a Launch Site Support Manager (LSSM) is assigned to be the customer's point of contact at the appropriate launch site.

Figure 6-2.- STS/payload requirements definition document.



As they are developed, all of the technical requirements and agreements required to integrate the payload into the STS are documented in a PIP. Detailed requirements and agreements, including the detailed launch site requirements, are documented in annexes to the PIP. Although documented separately for convenience, these annexes are considered to be part of the PIP. Annexes are described more completely in section 6.3. Figure 6-2 illustrates the relationship between the customer-specific documents discussed in this section and the generic documents discussed in section 5.

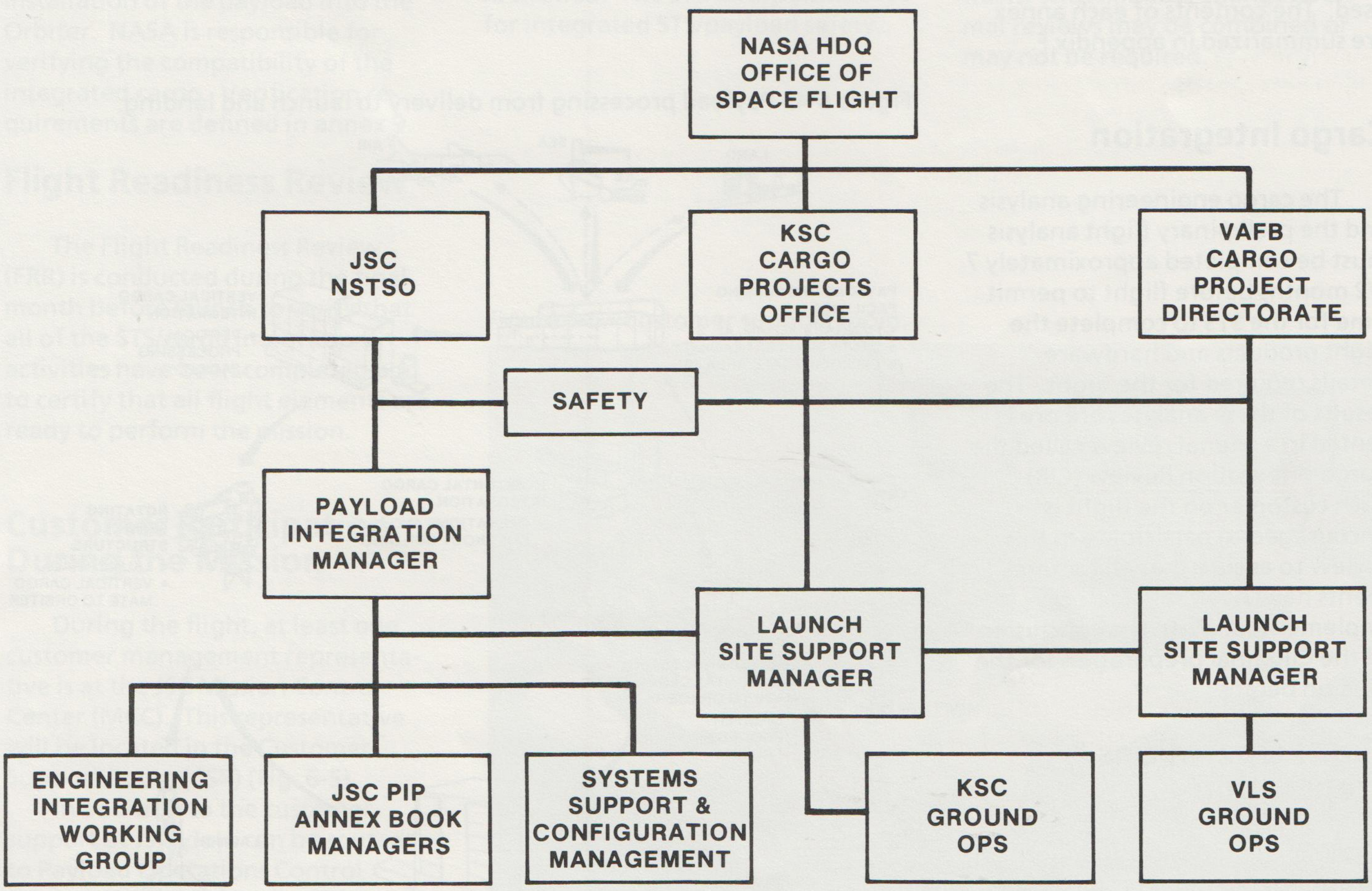
When agreed to and signed by both the customer and NASA, the PIP becomes the technical contract. It in turn becomes part of the formal contract by reference in the LSA.

Once the major technical requirements are understood and agreed to, preparation of the Interface Control Document (ICD) begins, as well as the definition of any engineering analyses required by the customer to support the design (loads analysis, etc.). The ICD is based on the options described in the appropriate Interface Definition Document (IDD) as discussed in section 5. The specific options required by the customer are documented in the ICD along with any unique interfaces required to accomplish the customer's objectives.

6.3 Flight Implementation Process

After the formal agreements have been reached and a preliminary flight assignment released, NASA conducts preliminary cargo engineering analysis and mission planning to determine if the cargo

Figure 6-3.- Payload integration management organization.



elements are compatible with each other and with the Space Transportation System (STS) capabilities. To conduct these analyses, NASA needs certain design details on each payload. These details are obtained from and verified by the customer and are documented in annexes to the PIP. Book Managers are appointed by the responsible JSC organization to work with customers to prepare the annexes. Since the Book Managers are intimately familiar with the design details to be used, they usually prepare the annexes themselves working with their counterparts in the customer's organization. This process has proven to be very efficient and effective from both NASA's and the customer's perspective. There are presently 10 annexes numbered 1 through 11. Annex 10 is no longer used. The contents of each annex are summarized in appendix F.

Cargo Integration

The cargo engineering analysis and the preliminary flight analysis must be completed approximately 7 1/2 months before flight to permit time for the STS to complete the flight products and hardware details required for the flight. The results of these analyses are presented in a formal review called the Cargo Integration Review (CIR). Each customer on the flight is encouraged to participate in this review to ensure that all requirements have been satisfactorily implemented. With the conclusion of the CIR, final preparation for the mission begins.

Flight Operations Preparation

Final flight design and flight operations planning products are completed as well as any modifications (including software) required by the Mission Control Center (MCC), Payload Operations Control Center (POCC), and crew training facilities. These products are formally reviewed by the Flight Operations Review (FOR) board. This review is held approximately 3 months before flight to support the final phase of flight crew and flight operations personnel training.

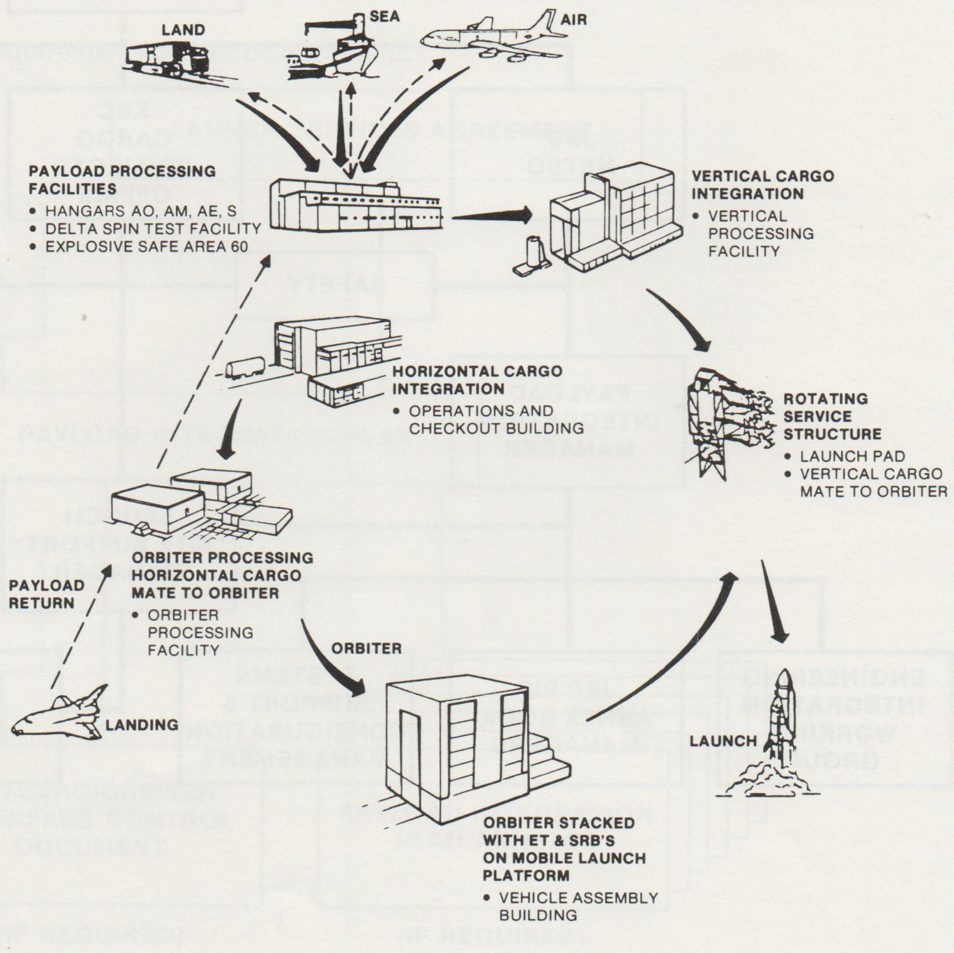
Launch and Landing Site

The payloads undergo final checkout, interface verification, and launch preparation at the launch site. There are two Space Shuttle launch sites: KSC, Florida for orbit inclinations up to 57 degrees and Vandenberg Air Force Base (VAFB), California for high orbit inclination. (Reference section 8.)

Standard facilities and services are available and are allocated on the basis of customer requirements. The KSC facilities and services are defined in the *KSC Launch Site Accommodations Handbook for STS Payloads (K-STSM-14.1)*.

In the typical flow at KSC (Fig. 6-4), the arriving payload goes through a payload processing facility (PPF). Generally, this begins with receiving inspection and includes any component or subsystem assembly necessary, such as mating to its upper stage or carrier. The payload is checked and serviced. It then goes to either the horizontal or vertical cargo integration facility, where it is integrated with any other payloads scheduled for the same flight.

Figure 6-4.- Payload processing from delivery to launch and landing.



The integrated cargo undergoes interface and system verification testing and is then installed into the Orbiter, either horizontally in the Orbiter Processing Facility (OPF) at KSC (the Orbiter Maintenance and Checkout Facility (OMCF) at VAFB) or vertically at the launch pad.

After Orbiter landing, the payload is returned to a PPF and prepared for shipment back to the customer's facility.

Preflight Verification

The user is responsible for verifying the compatibility of payload physical and functional interfaces with the applicable interface agreements prior to installation of the payload into the Orbiter. NASA is responsible for verifying the compatibility of the integrated cargo. Verification requirements are defined in annex 9.

Flight Readiness Review

The Flight Readiness Review (FRR) is conducted during the final month before launch to verify that all of the STS/cargo integration activities have been completed and to certify that all flight elements are ready to perform the mission.

Customer Participation During the Mission

During the flight, at least one customer management representative is at the JSC Mission Control Center (MCC). This representative will be located in the Customer Support Room (CSR) (Fig. 6-5).

In addition to the customer support at JSC, data can be routed to Payload Operations Control Centers (POCC's) at various locations. POCC's can be used to command and control payload operations as well as to receive payload data.

Before a mission, the customer participates in control team training, which consists of briefings and simulations. Simulations will usually begin 2 months before launch. These simulations include a fully-staffed MCC, the Space Shuttle mission simulator and crew, and remote customer locations. During these simulations, customers will normally be involved in several training sessions to rehearse various mission events.

6.4 Payload Safety

Payload safety is a customer responsibility. The STS establishes the safety requirements for payloads and works with the customer to resolve any payload hazards identified. The STS is responsible for integrated STS/payload safety.

Figure 6-5.- Customer support room.

The basic review process begins with an informal meeting at the earliest appropriate time to brief the customer on the technical and system safety requirements including instructions for the conduct of the joint phased safety reviews. These reviews normally correspond to the payload's Design Requirements Review (DRR), Preliminary Design Review (PDR), Critical Design Review (CDR), and hardware delivery.

However, both the number and the scope of these reviews may be tailored to meet the individual customer's situation. For example, if the payload is simple, with minimal hazard potential, a teleconference may be adequate. Or, if the payload design is mature, such as one of a series of payloads being flown with minimal changes, formal reviews may be combined or may not be required.

Pricing Summary

7

The Space Shuttle offers transportation services at competitive prices. All pricing data in this document are provided for information only and are based on the best information available at the time of publication; however, the National Aeronautics and Space Administration (NASA) may amend the pricing policy according to U.S. Government regulations. This document, therefore, is not an offer to sell or act as an agent for any potential customer.

The standard transportation charge covers the basic activities associated with launching a payload and operating it on orbit, including deployment if necessary. The charge for payloads in the cargo bay is based on a load factor, i.e., the fraction of weight or length of the payload when compared with total Orbiter capability.

7.1 Standard Launch Services

Space Shuttle standard launch services include the following:

- Launch from the NASA John F. Kennedy Space Center (KSC)
- 160-nautical mile altitude
- 28.45-degree inclination
- Up to 1 day of mission operations
- A trained flight crew (commander, pilot, and Mission Specialists)
- Payload deployment, if required
- Orbiter flight planning services
- Payload operations in orbit
- Prelaunch payload operations
- Orbiter interface compatibility and verification testing
- Transmission of payload data between the Orbiter and the Mission Control Center (MCC)
- NASA payload safety reviews
- All STS-related training for crewmembers and ground personnel
- Integration of approved payloads into cargo manifest and flight schedules

Additionally, a wide range of optional services is available, including engineering analyses, special ground processing, extra services while in orbit, and the flight of customer personnel as Payload Specialists (PS's). For more details, see STS *Optional Services Pricing Manual, JSC-20109.*

7.2 Space Shuttle Pricing Policy

The Space Shuttle pricing policy allows a standard fixed price for a dedicated launch, with associated standard services available to all users, and allows additional charges for optional services unique to individual users. Prices are based on 1982 dollars unless otherwise noted. Escalation for inflation will be computed according to the Bureau of Labor Statistics index for the "Private Business Sector, all persons: productivity, hourly compensation, unit labor cost and prices seasonally adjusted." The price for standard launch services on the Space Shuttle is set for a dedicated flight and then prorated for shared payloads which do not require the full capability of the Space Shuttle. The price charged to a customer for standard launch services is $71 million for a launch between October 1, 1985, and September 30, 1988. The post-1988 price has been established as not less than $74 million. A small payload pricing policy is under review by NASA Headquarters for publication at a later date.

7.3 Load Factors

The price charged to a customer is based on the percentage of the Orbiter's weight or length capability that the customer's payload uses. To determine these load factors, the total weight (including all support equipment) and the total length (including 6 inches for dynamic clearance) are divided by the Orbiter's capabilities as follows:

$$\text{Length load factor} = \frac{\text{total payload length}}{720 \text{ inches}}$$

$$\text{Weight load factor} = \frac{\text{total payload weight}}{65{,}000 \text{ pounds}}$$

The larger of the two load factors determines the charge factor. This charge factor is calculated by dividing the larger load factor by 0.75 . The shared flight price for standard services is calculated by multiplying the charge factor by the dedicated flight price.

EXAMPLE:

The charge factor for a 100-inch payload weighing 10,000 pounds and launched into a standard 160-nautical mile, 28.45-degree orbit would be determined as follows:

$$\text{Length load factor} = \frac{100 \text{ inches}}{720 \text{ inches}} = 0.139$$

$$\text{Weight load factor} = \frac{10{,}000 \text{ pounds}}{65{,}000 \text{ pounds}} = 0.154$$

Since the weight load factor is greater, it determines the charge factor.

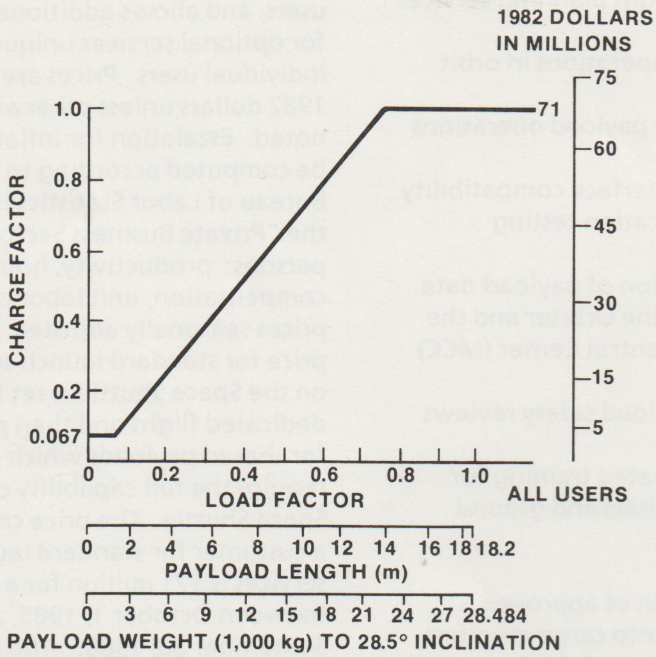


Figure 7-1.- Shuttle standard launch services price (for flights between FY86-88).

$$\text{Charge factor} = \frac{\text{Larger load factor}}{0.75} = \frac{0.154}{0.75} = 0.206$$

Thus, the payload's shared flight price would be the dedicated flight price multiplied by 0.206.

Figure 7-1 is a nomograph that can be used to make a preliminary price estimate for Space Shuttle standard launch services. The horizontal scales determine payload length and weight factors. The charge factor is found by reading up from the larger load factor. By reading over to the price scale on the right, customers can determine their launch services price.

A customer's total price includes the standard launch price, any optional services ordered by the customer, and any optional flight system(s), such as a NASA-supplied carrier.

7.4 Reimbursement

The launch price is paid to NASA according to the fixed payment schedule shown on figure 7-2. At the time of payment, the portion of the launch price that is fixed in 1982 dollars is then escalated to current dollars using the appropriate Bureau of Labor Statistics index. Generally speaking, optional services are paid for at the time the service is performed. An accelerated payment schedule is under development for payloads manifested less than 33 months prior to launch. A miscellaneous services account may be set up with NASA Headquarters to handle payments for optional services.

Figure 7-2.- Fixed payment schedule.

Contract Initiation (months before launch)	Payment Due Months Before Launch (%)						Total Payment (%)
	33	27	21	15	9	3	
Nominal schedule 33 or more	10	10	15	25	25	15	100

STS/Space Shuttle Organization

8

Several NASA centers are involved with activities of interest to STS customers ranging from scientific involvement on specific experiments to the operation of the payload during a flight. The following organizations are directly involved with the integration of a payload into the STS.

8.1 NASA Headquarters

Overall management of the STS is the responsibility of the Office of Space Flight at the National Aeronautics and Space Administration (NASA) Headquarters in Washington, D.C. This office creates policies related to the use of the Space Shuttle and sets the price for standard launch services (reference section 7).

The Customer Services Division within the Office of Space Flight handles the Request for Flight Assignment (STS Form 100), earnest money payments and progress payments and negotiates the Launch Services Agreement (LSA). The Customer Services Division assigns a Customer Service Manager to each customer to serve as the main point of contact with NASA Headquarters.

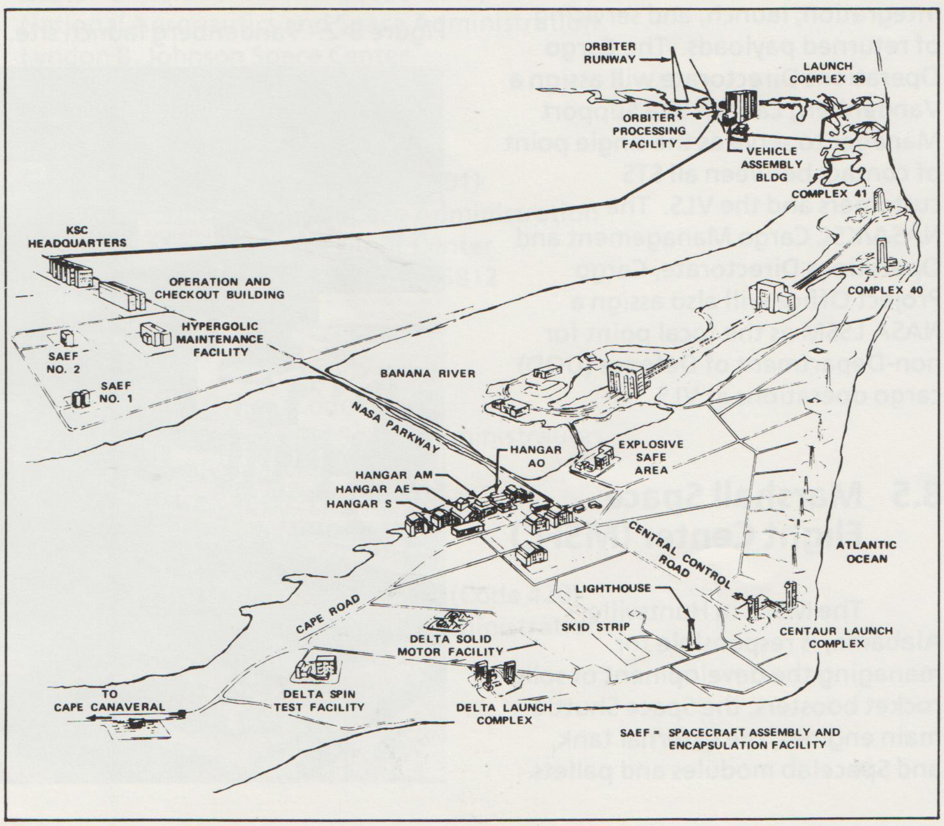
8.2 Lyndon B. Johnson Space Center (JSC)

The National Space Transportation System Office (NSTSO) at JSC, Houston, Texas, is responsible for managing the development and operation of the Space Shuttle.

The JSC Customer Integration Office is responsible for managing the integration of the customer's payload into the STS. A Payload Integration Manager (PIM) is assigned to each customer to serve as the single point of contact between the customer and the STS for technical integration.

Working groups for engineering and operations planning are established as needed between the customer and the STS. These working groups define interface and operational requirements, identify and define engineering tasks and analyses, and exchange required data.

Figure 8-1.- John F. Kennedy Space Center.



8.3 John F. Kennedy Space Center (KSC)

The KSC is one of the launch and landing sites for the STS. Located on Merritt Island, Florida, KSC is responsible for implementing the activities associated with preparing the Space Shuttle and its payloads for launch and for post-flight servicing. The physical layout of KSC is presented on figure 8-1.

The Cargo Projects Office at KSC is responsible for payload processing and support at the launch site. Each customer is assigned a Launch Site Support Manager (LSSM) to serve as a single point of contact between the customer and KSC for all launch site support and payload processing matters. Specific launch site services are negotiated in the Payload Ground Operations Working Group.

8.4 Vandenberg Launch and Landing Site (VLS)

The Vandenberg Air Force Base (VAFB) is expected to be the primary launch and landing site for all high inclination flights. VAFB is responsible for all Space Shuttle activity at the Vandenberg Launch and Landing Site (VLS). The VLS is located at the southern end of VAFB in California as shown in figure 8-2. The Cargo Operations Directorate (Code SH) manages all cargo activity in VLS facilities, including payloads processing, integration, launch, and servicing of returned payloads. The Cargo Operations Directorate will assign a Vandenberg Launch Site Support Manager to serve as the single point of contact between all STS customers and the VLS. The NASA/KSC Cargo Management and Operations Directorate, Cargo Project Office will also assign a NASA LSSM as the focal point for non-Department of Defense (DOD) cargo operations at VLS.

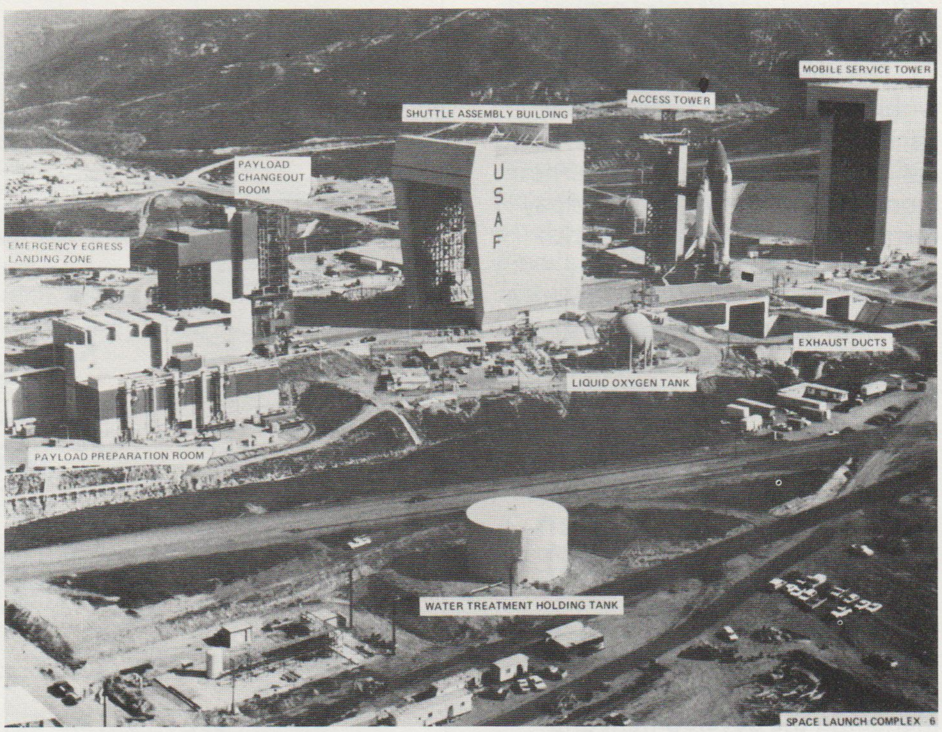
8.5 Marshall Space Flight Center (MSFC)

The MSFC in Huntsville, Alabama, is responsible for managing the development of solid rocket boosters, the Space Shuttle main engines, the external tank, and Spacelab modules and pallets.

8.6 Goddard Space Flight Center (GSFC)

The GSFC, in Greenbelt, Maryland, is responsible for managing the world-wide NASA communications network including the Spaceflight Tracking and Data Network (STDN). In addition, GSFC manages the Get Away Special (GAS) program and has several other small payload carrier programs in development.

Figure 8-2.- Vandenberg launch site.



Appendix A
Contacts

Customer Services Division (Code MC)
National Aeronautics and Space Administration
Washington, D. C. 20546
202-453-2347

Customer Integration Office (Code TC)
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058
713-483-2343

Customer Service Center (Code TC12)
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058
713-483-2337

Customer Relations Office (Code TC13)
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058
713-483-3543

Spacelab Program Office (Code NA01)
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812
205-544-4722

Cargo Projects Office (Code CP)
National Aeronautics and Space Administration
John F. Kennedy Space Center
Kennedy Space Center, FL 32899
305-867-4545

Attached Shuttle Payload Program (Code 420)
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771
301-344-4968

Appendix B
Reference Documents List

Safety Requirements

Safety Policy and Requirements for Payloads Using the Space Transportation System (STS), NHB 1700.7A

Space Transportation System Payload Ground Safety Handbook, SAMTO HB S-100/KHB 1700.7

Implementation Procedures for STS Payloads Safety Requirements, JSC-13830

Standard Integration Plans (blank books)

Shuttle/Payload Standard Integration Plan for Small Payload Accommodations, JSC-21000-SIP-SML

Shuttle/Payload Standard Integration Plan for Standard Accommodations (Deployable), JSC-21000-SIP-DEP

Shuttle/Payload Standard Integration Plan for Middeck-Type Payload Accommodations, JSC-21000-SIP-MDK

Shuttle/Payload Standard Integration Plan for Payload Specialist Payloads, JSC-21000-SIP-PSP

Shuttle/Payload Standard Integration Plan for DOD Deployable/Retrievable-Type Payloads, JSC-21000-SIP-DOD

Shuttle/Payload Standard Integration Plan for Spacelab Payload (Generic), JSC-21000-SIP-XXX

Shuttle/Payload Standard Integration Plan for Standard Accommodations (Attached), JSC-21000-SIP-XXX

Shuttle Payload Standard Integration Plan for Deployable/Retrievable Payloads, JSC-21000-SIP-XXX

Interface Definition Documents

Shuttle/Payload Interface Definition Document for Standard Accommodations, JSC-21000-IDD-STD

Shuttle/Payload Interface Definition Document for Small Payload Accommodations, JSC-21000-IDD-SML

Shuttle/Payload Interface Definition Document for Middeck Payload Accommodations, JSC-21000-IDD-MDK

Standard PIP Annexes (blank books)

Annex 1 - *Payload Data Package*, JSC-21000-A0I

Annex 2 - *Flight Planning Data Requirements*, JSC-21000-A02

Annex 3 - *Support Data Requirements for Flight Operations*, JSC-21000-A03

Annex 4 - *Command and Data Requirements*, JSC-21000-A04

Annex 5, Volume I - *JSC Attached Payload Operations Control Center (POCC)*, JSC-21000-A05 VI

Annex 5, Volume 2 - *MCC/Remote POCC Requirements*, JSC-21000-A05 V2

Annex 5, Volume 2a - *MCC/Remote POCC Requirements for DOD Payloads*, JSC-21000-A05 V2a

Annex 6 - *Crew Compartment Data Requirements*, JSC-21000-A06

Annex 7 - *Training Data Requirements*, JSC-21000-A07

Annex 8 - *Launch Site Support Plan*, K-STSM-11.0

Annex 9 - *Payload Verification Requirements*, JSC-21000-A09

Annex 11 - *EVA Data Requirements*, JSC-21000-A11

Carrier Accommodations

Spacelab Payload Accommodations Handbook, ESA-SLP-2104

Get Away Special (GAS) Small Self-Contained Payloads (Unnumbered)

Launch Site Accommodations

KSC Launch Site Accommodations Handbook for STS Payloads, K-STSM-14.1

Shuttle/Payload Integration Information Documents

Shuttle/Payload Integration Activities Plan, JSC-21000-IAP

Shuttle/Payload Integration Information Document for Structures and Mechanics, JSC-(TBD)

Shuttle/Payload Integration Information Document for Thermal Properties , JSC-(TBD)

Shuttle/Payload Integration Information Document for Avionics, JSC-(TBD)

Shuttle/Payload Integration Information Document for Remote Manipulator System, JSC-(TBD)

Shuttle/Payload Integration Information Document for Environments, JSC-(TBD)

Shuttle/Payload Integration Information Document For Extravehicular Activities (EVA), JSC-(TBD)

NSTS Optional Services Pricing Manual, JSC-20109

Miscellaneous

Shuttle Integration Bulletin

Customer's Guide to JSC

Appendix C
STS Form 100

Figure C-1.- STS form 100 (Sheet 1 of 2).

STS 100 FORM (REV C) | **REQUEST FOR FLIGHT ASSIGNMENT** | **DATE:**

TO:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SPACE TRANSPORTATION SYSTEMS UTILIZATION
MAIL CODE: OT
WASHINGTON, D.C. 20546

FROM:

PRINCIPAL CONTACT:
TELEPHONE:

PAYLOAD TITLE:

USER CATEGORY:

_____ ESA
_____ DOD
_____ NASA
_____ Other U.S. Government
_____ Domestic commercial
_____ Foreign commercial
_____ Foreign Government

FLIGHT TYPE:

_____ Shared
_____ Retrieval
_____ Attached
_____ Dedicated
_____ Revisit/service
_____ Deployable

CARRIER:

_____ Spacelab (specify) ____________________
_____ Other (specify) ____________________
_____ IUS (specify) ____________________
_____ SSUS-A _____ SSUS-D _____ MMS

PAYLOAD OBJECTIVES:

PAYLOAD ORBIT REQUIREMENTS:

SHUTTLE ORBIT REQUIREMENTS:

__________ 160NM altitude/28.5° inclination
__________ 160NM altitude/57° inclination
__________ NM altitude/__________ ° inclination

CARRIER (OR FINAL) ORBIT REQUIREMENTS (deployable only):

__________ NM apogee altitude
__________ NM perigee altitude
__________ deg inclination
__________ deg argument of perigee

FINAL ORBIT REQUIREMENTS (deployable only):

____
____
____

PAYLOAD LAUNCH DATE(S) REQUESTED (month and year):

First launch (scheduled, stand-by or short-term call-up) ____________________
Second launch (scheduled, stand-by or short-term call-up) ____________________
Third launch (scheduled, stand-by or short-term call-up) ____________________
Fourth launch (scheduled, stand-by or short-term call-up) ____________________
____
____

(over)

Figure C-1.- STS form 100 (Sheet 2 of 2).

PAYLOAD MISSION DURATION REQUIRED:

_______________ hours/days

_______________ no requirement

UNIQUE PAYLOAD CONSTRAINTS:

____

____

____

PAYLOAD CHARACTERISTICS:*

	wgt (lb/kg)	max dia (in/cm)	max lgth (in/cm)	cg (in/cm)
Launch				
Retrieval/landing				

Radio frequencies T/M _______ Cmd _______ other _______

* THE TERM PAYLOAD REFERS TO ALL USER PROVIDED EQUIPMENT

QUESTIONAIRE:

Has earnest money been submitted? _______________

Is apportionment/assignment anticipated? _______________

List any anticipated optional services you may require. _______________

____

____

Does your organization have copies of standard STS documentation? _______________

____

REMARKS: _______________

____

____

____

/s/ _______________ Title: _______________

Appendix D

ACRONYMS AND ABBREVIATIONS

APC	autonomous payload controller
ASE	airborne support equipment
CDR	Critical Design Review
CIR	Cargo Integration Review
CSR	Customer Support Room
DOD	Department of Defense
DRR	Design Requirements Review
DSN	Deep Space Network
EAFB	Edwards Air Force Base
ET	external tank
EVA	extravehicular activity
ETR	Eastern Test Range
FOR	Flight Operations Review
FRR	Flight Readiness Review
GAPC	Get Away Special Autonomous Payload Controller
GAS	Get Away Special
g	gravity
GMT	Greenwich Mean Time
GPC	general purpose computer
GSE	ground support equipment
ICD	Interface Control Document
IDD	Interface Definition Document
IRIG-B	Interrange Instrumentation Group B
IUS	Inertial Upper Stage
JSC	NASA Lyndon B. Johnson Space Center
KSC	NASA John F. Kennedy Space Center
LCD	liquid crystal display
LSA	Launch Services Agreement
LSSM	Launch Site Support Manager
MCC	Mission Control Center
MDM	multiplexer/demultiplexer
MET	mission-elapsed time
MS	Mission Specialist
NASA	National Aeronautics and Space Administration
NRZ	non-return-to-zero
OMCF	Orbiter Maintenance and Checkout Facility
OMS	Orbital Maneuvering System
OPF	Orbiter processing facility
PDI	payload data interleaver
PDR	preliminary design review
PI	payload interrogator
PIM	Payload Integration Manager
PIP	Payload Integration Plan
POCC	Payload Operations Control Center
PPF	payload processing facility
PS	payload specialist
PSK	phase-shift-key
PSP	payload signal processor
RF	radio frequency
RMS	Remote Manipulator System
RSS	rotating service structure
SIP	standard interface panel
SIP	standard integration plan
SMCH	standard mixed cargo harness
SSME	Space Shuttle main engine
SRB	solid rocket booster
SSP	Standard Switch Panel
STDN	Spaceflight Tracking and Data Network
STS	Space Transportation System
TDRSS	Tracking and Data Relay Satellite System
VAFB	Vandenberg Air Force Base
VLS	Vandenberg Launch and Landing Site
WTR	Western Test Range

Appendix E
Glossary

Attached Payload:
Payload which remains in the cargo bay and is not deployed on-orbit.

Autonomous Payload Controller (APC) System:
A crew-operated hand-held digital communications unit for sending commands to payloads and receiving execution responses.

Cargo:
The total complement of payloads (one or more) on any one flight. It includes everything contained in the Orbiter cargo bay plus other equipment, hardware, and consumables located elsewhere in the Orbiter which are user-unique and are not carried as part of the basic Orbiter payload support.

Cargo Bay:
The unpressurized midpart of the Orbiter fuselage behind the cabin aft bulkhead where most payloads are carried. Its maximum usable payload envelope is approximately 15 feet (4.6 m) in diameter and 60 feet (18.3 m) in length. The cargo bay doors extend the full length of the bay.

Command Services:
Command services include on-board discrete and POCC serial digital commands.

Dedicated Mission:
A mission which, because of size, weight, or other considerations, is devoted to the needs of a single customer.

Deep Space Network (DSN):
Communications network managed by the Jet Propulsion Laboratory (JPL) for command and control of all planetary flights.

Deployment:
The process of removing a payload from a stowed or berthed position in the cargo bay and releasing that payload to a position free of the Orbiter.

Detached Payload:
A payload which is deployed from the Orbiter cargo bay on-orbit.

Eastern Test Range (ETR):
The Kennedy Space Center (KSC) launch site for Shuttle flights.

Edwards Air Force Base (EAFB):
The Edwards Air Force Base in southern California is the Secondary Landing Site for Shuttle flights.

European Space Agency (ESA):
An international organization acting on behalf of its member states (Belgium, Denmark, France, Federal Republic of Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom). The ESA directs a European industrial team responsible for the development and manufacture of Spacelab.

Experimenter:
A user of the Space Transportation System, ordinarily an individual whose experiment is a small part of the total payload.

External Tank (ET):
Element of the Space Shuttle system which contains liquid propellant and oxidizer for the Orbiter main engines. It is jettisoned before orbit insertion.

Extravehicular Activity (EVA):
Activities by crewmembers conducted outside the spacecraft pressure hull or within the cargo bay when the cargo bay doors are open.

Flight:
The period from launch to landing of an Orbiter - a single Shuttle round trip. One flight might deliver more than one payload or more than one flight might be required to accomplish a single mission.

Flight Design:
The trajectory, consumables, attitude and pointing, and navigation analyses necessary to support the planning of a flight.

Flight Manifest:
The designation of a flight, assignment of the cargo to be flown, and specific implementing instructions for STS operations personnel.

Flight Phases:
Prelaunch, launch, on orbit, deorbit, entry, landing, and postlanding.

Flight Types:
Payload deployment and retrieval, on-orbit servicing of satellites, and on-orbit operations with an attached payload, as suited to the purposes of a mission. A single flight might include more than one of these purposes.

Get Away Special (GAS):
Small payloads mounted in canisters in the Orbiter cargo bay.

Grapple Fixture:
Structural fitting on the detached payload to mate a payload to the end-effector on the Remote Manipulator System (RMS).

Inclination:
The maximum angle between the plane of the orbit and the equatorial plane.

Induced Environments:
Environments resulting from Orbiter operation such as acceleration, vibration, acoustics, etc.

Inertial Upper Stage (IUS):
Solid propulsive upper stage designed to place spacecraft on high Earth orbits or on escape trajectories for planetary missions.

Insertion:

Standard Insertion: An ascent targeting technique, normally used for relatively low-altitude orbits, in which two firings of the orbital maneuvering engines are used to achieve the final operational orbit.

Direct Insertion: An ascent targeting technique, normally used for relatively high-altitude orbits, in which a single firing of the orbital maneuvering engines is used to achieve the final operational orbit.

Nodal Insertion: An ascent targeting technique, normally used for Vandenberg missions requiring medium-altitude orbits, in which two firings of the orbital maneuvering engines are required to achieve the final operational orbit.

Integration:
A combination of activities and processes to assemble payload and STS components, subsystems, and system elements into a desired configuration and to verify compatibility among them.

Interface:
The mechanical, electrical, and operational common boundary between two elements of a system.

Interface Verification:
Testing of flight hardware interfaces by an acceptable method that confirms that those interfaces are compatible with the affected elements of the Space Transportation System.

Ku-Band Signal Processor:
The Ku-Band Signal Processor receives high data rate scientific data from small payloads in the payload bay and transfers the data to the Orbiter communication system.

Launch Pad:
The area at which the stacked Space Shuttle undergoes final prelaunch checkout and countdown and from which it is launched.

Launch Site Support Manager (LSSM):
The individual at KSC or VAFB who is the single point of contact with users in arranging payload processing at their respective launch sites.

Load Factors:
The load factors to be used in determining the price charged to a customer are the percentages of the Orbiter's weight or length capability that the customer's payload uses. To determine these load factors, the total payload weight and total payload length are divided by the Orbiter's capabilities.

Middeck Payload:
Payload or experiment requiring pressurized crew compartment accommodations.

Mission:
The performance of a coherent set of investigations or operations in space to achieve program goals. A single mission might require more than one flight, or more than one mission might be accomplished on a single flight.

Mission Control Center (MCC):
Facility located at JSC for control and support of all phases of STS flights after launch.

Mission Specialist:
The crewmember who is responsible for coordination of overall payload/STS interaction and, during the payload operation phase, directs the allocation of the STS and crew resources to the accomplishment of the combined payload objectives. The mission specialist will have prime responsibility for experiments to which no payload specialist is assigned and/or will assist the payload specialist when appropriate.

Mission Station:
Location on the Orbiter aft flight deck from which payload support operations are performed, usually by the mission specialist.

Mixed Payloads:
Cargo containing more than one type of payload.

Multiplexer/Demultiplexer (MDM):
The MDM acts as a data acquisition, distribution, and signal conditioning unit. It converts serial digital information from the GPC to analog and discrete outputs for payload operations, and acquires analog and discrete signals from the payload and converts them to serial digital signals for on-board processing by the Orbiter GPC.

Optional Service:
Additional services and accommodations available at additional charges.

Orbiter:
The manned orbital flight vehicle of the Space Shuttle system.

Orbiter Maintenance and Checkout Facility (OMCF):
The OMCF is at VAFB where the Orbiter undergoes postflight inspection, maintenance, and premate checkout before payload installation.

Orbital Maneuvering System (OMS):
Orbiter engines that provide the thrust to perform orbit insertion, circularization, or transfer; rendezvous; and deorbit.

Orbiter Processing Facility (OPF):
Building near the Vertical Assembly Building (VAB) at KSC with two high bays in which the Orbiter undergoes postflight inspection, maintenance, and premate checkout before payload installation. Payloads are also installed horizontally in the Orbiter in this building.

Payload:
The total complement of specific instruments, space equipment, support hardware, and consumables carried in the Orbiter (but not included as part of the basic Orbiter payload support) to accomplish a discrete activity in space.

Payload Carrier:
Payload carriers are for use with the Space Shuttle to obtain low-cost payload operations. The payload carriers are identified as habitable modules (Spacelab) and attached but uninhabitable modules (pallets, free-flying systems, satellites, and upper stages).

Payload Data Bus:
The payload data bus provides compatible interface matching, isolation, and fault protection to allow the payload bus terminal unit and the Orbiter GPC to operate as a digital transmission system.

Payload Data Interleaver (PDI):
The PDI provides the interface for acquiring asynchronous pulse code modulation (PCM) telemetry from attached and detached payloads.

Payload Interrogator (PI):
The payload interrogator provides RF communications between the Orbiter and detached payloads.

Payload Operations Control Center (POCC):
Ground facilities from which payload operations are monitored and controlled.

Payload Recorder:
The payload recorder can record analog or digital data from attached payloads for limited periods of time.

Payload Signal Processor (PSP):
The PSP transmits serial digital commands to one detached payload via the Payload Interrogator or one attached payload selected by the crew or ground station.

Payload Specialist (PS):
The crewmember who is responsible for the operation and management of the experiments or other payload elements that are assigned to him or her and for the achievement of their objectives. The payload specialist will be an expert in experiment design and operation and may or may not be a career astronaut.

Payload Station:
Location on the Orbiter aft flight deck from which payload-specific functions are performed, usually by the payload or mission specialist.

Postretrieval:
Activities after a payload has been returned and secured in the cargo bay.

Program:
An activity involving manpower, material, funding, and scheduling necessary to achieve desired goals.

Remote Manipulator System (RMS):
Mechanical arm on the cargo bay longeron. It is controlled from the Orbiter aft flight deck to deploy, retrieve, or move payloads.

Retention Latches:
Structural retention of payload in cargo bay with longeron and keel fittings.

Retrieval:
The process of using the remote manipulator system and/or other handling aids to return a captured payload to a stowed or berthed position. No payload is considered retrieved until it is fully stowed for safe return or berthed for repair and maintenance tasks.

Rotating Service Structure (RSS):
The RSS is the launch pad service structure including the Payload Changeout Room (PCR) which rotates out to the Orbiter on the Mobile Launch Platform (MLP).

Solid Rocket Boosters (SRB's):
Element of the Space Shuttle which consists of two solid rocket motors to augment ascent thrust at launch. They are separated from the Orbiter soon after lift-off and recovered for reuse.

Spaceflight Tracking and Data Network (STDN):
A number of ground-based stations having direct communications with NASA flight vehicles.

Spacelab:
A general-purpose orbiting laboratory for manned and automated activities in near-Earth orbit. It includes both module and pallet sections, which can be used separately or in several combinations.

Space Radiators:
Thermal radiating panels on the inside of the Orbiter cargo bay doors which are extended while on-orbit.

Space Shuttle:
Orbiter, external tank, and two solid rocket boosters.

Space Transportation System (STS):
An integrated system consisting of the Space Shuttle (Orbiter, external tank, solid rocket boosters, and flight kits), upper stages, Spacelab, and any associated flight hardware and software.

Standard Payload:
A payload installed in the Orbiter cargo bay using standard payload accommodations.

Standard Switch Panel (SSP):
The SSP provides switch closure and/or 28-volt dc commands and status indicators for payload operation and status monitoring.

STS Customer:
An organization or individual requiring the services of the Space Transportation System.

Tracking and Data Relay Satellite System (TDRSS):
Two-satellite communication system providing principal coverage from geosynchronous orbit for all STS flights.

Upper Stage:
Payload assist module (PAM) or inertial upper stage (IUS). Both are designed for launch from the Orbiter cargo bay and have propulsive elements to deliver payloads into orbits and trajectories beyond the capabilities of the Shuttle.

Vandenberg Launch Site (VLS):
The Vandenberg Air Force Base is used as a launch site for Shuttle flights.

Western Test Range (WTR):
The Vandenberg Air Force Base (VAFB) launch site for Shuttle flights.

Appendix F
PIP Annexes

Payload Integration Plan (PIP) Annexes have been developed to aid customers to outline the detailed data required to configure both flight and ground systems and to implement other integration functions as outlined in the PIP. Generic "blank book" annexes have been developed to allow the customer to enter appropriate data. Not all annexes are required for every payload. The annexes are:

- **Annex 1 - Payload Data Package -** Consists of payload mass properties, configuration drawings, radio frequency radiation data, and payload physical function data. (JSC-21000-A01)

- **Annex 2 - Flight Planning -** Includes data required to define:
  - Launch window and orbital parameters
  - Electrical power and cooling requirements
  - Deployment/retrieval/proximity operations requirements
  - Crew activity requirements
  - Attitude and pointing
  - Extravehicular activities
  - Launch window data including geographical constraints data
  - Pointing/timing target data for deployment of upper stages (JSC-21000-A02)

- **Annex 3 - Data Requirements for Flight Operations -** Identifies payload operations support plans; defines flight operations decisions, joint operations interface procedures, and malfunction procedures; and includes payload electrical power and command interface drawings. (JSC-21000-A03)

- **Annex 4 - Orbiter Command and Data -** Identifies individual commands required to operate the payload, measurements of the payload's status and health, and measurements for accomplishing payload objectives. Provides the necessary information for processing and interpreting data. (JSC-21000-A04)

- **Annex 5 - Data Requirements for the Payload Operations Control Center -** Defines and details the customer's requirements levied on the STS for POCC, remote POCC, and communications resources. (JSC-21000-A05)

- **Annex 6 - Crew Compartment -** Describes the payload-supplied equipment stowed or installed in the crew compartment and defines requirements affecting stowage installation, handling, or flight crew use and proposed stowage/installation of payload materials. Includes display and control and standard switch panel nomenclature requirements. (JSC-21000-A06)

- **Annex 7 - Training -** Identifies training of STS personnel provided by the customer, and POCC team training requirements; determines integrated simulation requirements, establishes training sequence flow, and provides payload training schedules. (JSC-21000-A07)

- **Annex 8 - Launch Site Support Plan -** Defines payload processing flow at the launch site, defines customer's launch and landing site requirements and NASA John F. Kennedy Space Center (KSC) commitments, and specifies KSC facilities/resources that fulfill customer requirements. (K-STSM-11.0)

- **Annex 9 - Payload Interface Verification Summary -** Identifies project-level verification agreements, payload-to-STS Interface Control Document (ICD) interfaces to be verified, the method of verification, and the location of verification. (JSC-21000-A09)

- **Annex 11 - Extravehicular Activities -** Defines specific design configuration details for each hardware-to-hardware and hardware-to-crew interface associated with the EVA support of a particular payload, including planned, unscheduled, and contingency EVA's. (JSC-21000-A11)

(Note that Annex 10 has been omitted.)

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